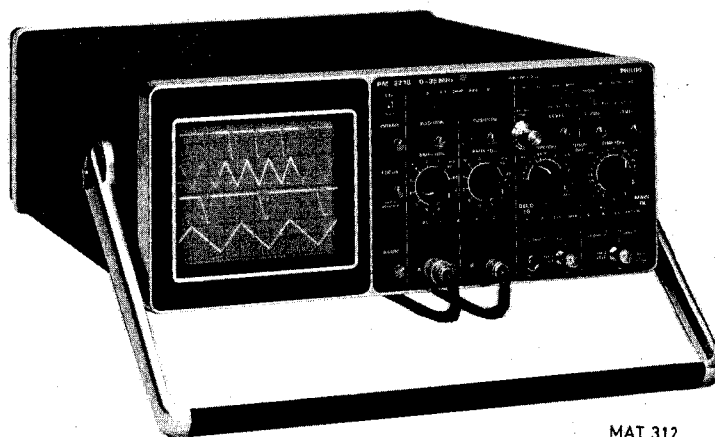


# PHILIPS



MAT 312

Instruction manual

Gerätehandbuch

Mode d'emploi

**35 MHz Dual channel oscilloscope**  
**35 MHz Zweikanal - Oszilloskop**  
**Oscilloscope 35 MHz à double trace**

## PM 3218

9444 032 18..1



9499 443 00102

190625

**IMPORTANT**

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

**WICHTIG**

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

**IMPORTANT****RECHANGE DES PIECES DETACHEES (Réparations)**

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

*Note: The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*

*Bemerkung: Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

*Remarques: Cet appareil est l'objet de développements et améliorations continus. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

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# 1. General information

## 1.1 INTRODUCTION

The 35 MHz dual-channel oscilloscope PM 3218 is a compact, portable instrument, ergonomically designed to facilitate its extensive measuring capabilities.

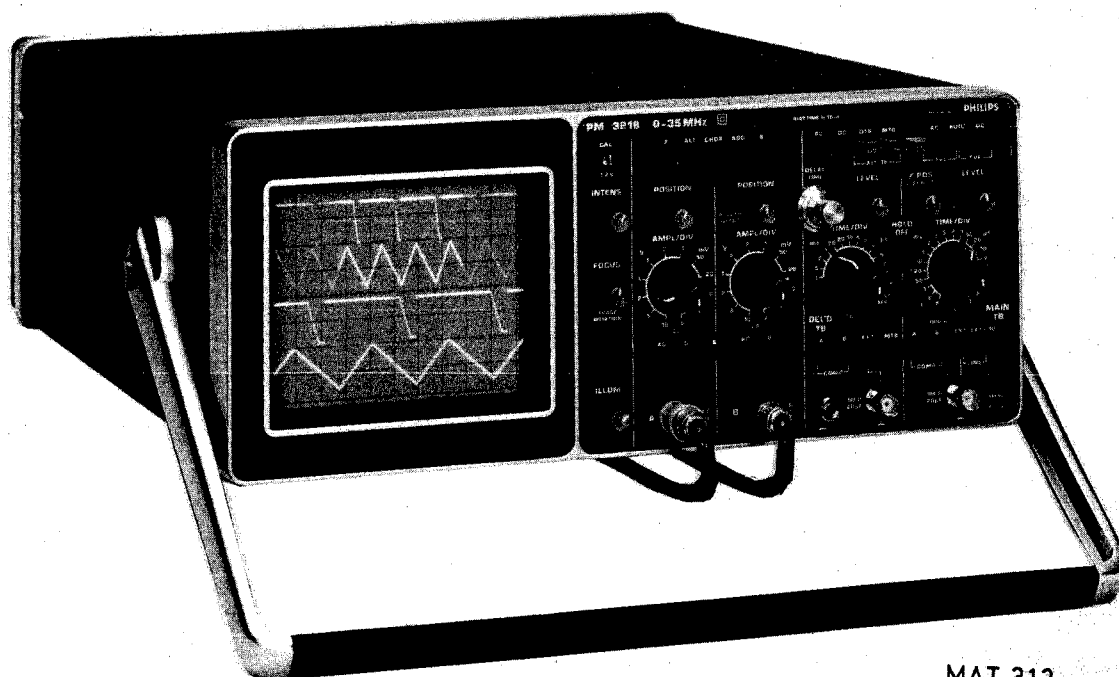
The instrument provides both a main and a delayed timebase with provision for alternate timebase displays, comprehensive triggering facilities including peak-to-peak Auto, DC coupling and automatic TV waveform display.

A large 8 x 10 cm screen with illuminated internal graticule lines makes for easier viewing, and a 10 kV accelerating potential gives a high intensity trace with a well-defined spot.

A double-insulated power supply allows the frame ground to be directly connected to floating ground circuits provided that this ground does not carry live potentials. By this means, interference by ground currents, as is frequently experienced with grounded oscilloscopes, is also substantially reduced.

The wide range of applications enabled by the above features is further extended by a versatile power supply that enables the instrument to be operated from different line voltages as well as from d.c. For field operation an optional battery version is also available.

**Warning: The frame ground (and the ground lead of the probe) must not be connected to live potentials.**



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Fig. 1.1. 35 MHz dual-channel oscilloscope PM3218

## 1.2. CHARACTERISTICS

This instrument has been designed and tested according to IEC Publication 348 for Class II instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition. Properties expressed in numerical values with stated tolerances are guaranteed for ambient temperatures of +5 °C ... +40 °C unless stated otherwise. Numerical values without tolerances are typical and represent the characteristics of an average instrument. The data apply after a warming-up period of 30 minutes.

| <i>Designation</i>                | <i>Specification</i>  | <i>Additional Information</i>  |
|-----------------------------------|---|--|
| <b>1.2.1 C.R.T.</b>               |   |  |
| Type                              | D14-125 GH/08   | Rectangular tube face, mesh type, post accelerator, metal backed phosphor. |
| Measuring area                    | 8 x 10 divisions  | 1 div. equals 1 cm   |
| Screen type                       | P31 (GH)  | P7 (GM) optional   |
| Total acceleration                | 10 kV   |  |
| Graticule                         | Internal  | Cont. variable illumination  |
| Engravings                        | Centimetre divisions with subdivisions of 2 mm along the central axes. Dotted lines indicate 10% and 90% of measuring lattice for measurement of rise time. |  |
| <b>1.2.2 Vertical or Y-axis</b>   |   |  |
| Display modes                     | Channel A only<br>Channel B only<br>A and B chopped<br>A and B alternating<br>A and B added   |  |
| Channel B polarity                | Normal or inverted  |  |
| Response:                         |   |  |
| Frequency range                   | DC : 0 .... 35 MHz (-3dB)<br>AC : 2 Hz .... 35 MHz (-3dB)   |  |
| Rise time                         | ≤ 10ns  |  |
| Pulse aberrations                 | ≤ ± 3% (≤ 4% pp)  | Measured at 6 div. amplitude and applied rise time of ≥ 1 ns.              |
| Deflection coefficients           | 2 mV/DIV .... 10 V/DIV  | 1-2-5 sequence   |
| Continuous control range          | 1 : ≥ 2,5   |  |
| Deflection accuracy               | ± 3 %   |  |
| Input impedance                   | 1 MΩ/20 pF  |  |
| Input RC time                     | 0,1 s   | Coupling switch to AC  |
| Maximum permissible input voltage | 400 V, d.c. + a.c. peak   |  |
| Chopping frequency                | ≈ 500 kHz   |  |
| Vertical positioning range        | 16 divisions  |  |
| Dynamic range                     | 24 divisions  |  |
| Visible signal delay              | ≥ 2 divisions   | At 10ns  |
| C.M.R.R. in A-B mode              | ≥ 40 dB at 1 MHz  | After adjustment at d.c. or low frequencies                                |
| Cross talk between channels       | -40 dB or better at 10 MHz  | Both attenuators in the same setting                                       |
| Instability of the spot position: |   |  |
| Temperature drift                 | ≤ 0,3 div/hour  |  |

### 1.2.3 Horizontal or X-axis

Horizontal deflection can be obtained from either the Main time base or the Delayed time base or a combination of the two, or from the signal source selected for X-deflection. In this case X-Y diagrams can be displayed using A, B, the Ext input connector, or Line as a signal source for horizontal deflection.

#### *Display modes*

- Main time base
- Main time base intensified by delayed time base
- Main time base and delayed time base alternately displayed
- Delayed time base
- XY or XY/Y operation

#### X deflection by:

- Channel A signal
- Channel B signal
- Signal applied to EXT connector of main time base
- Line frequency

### 1.2.4 Main time base

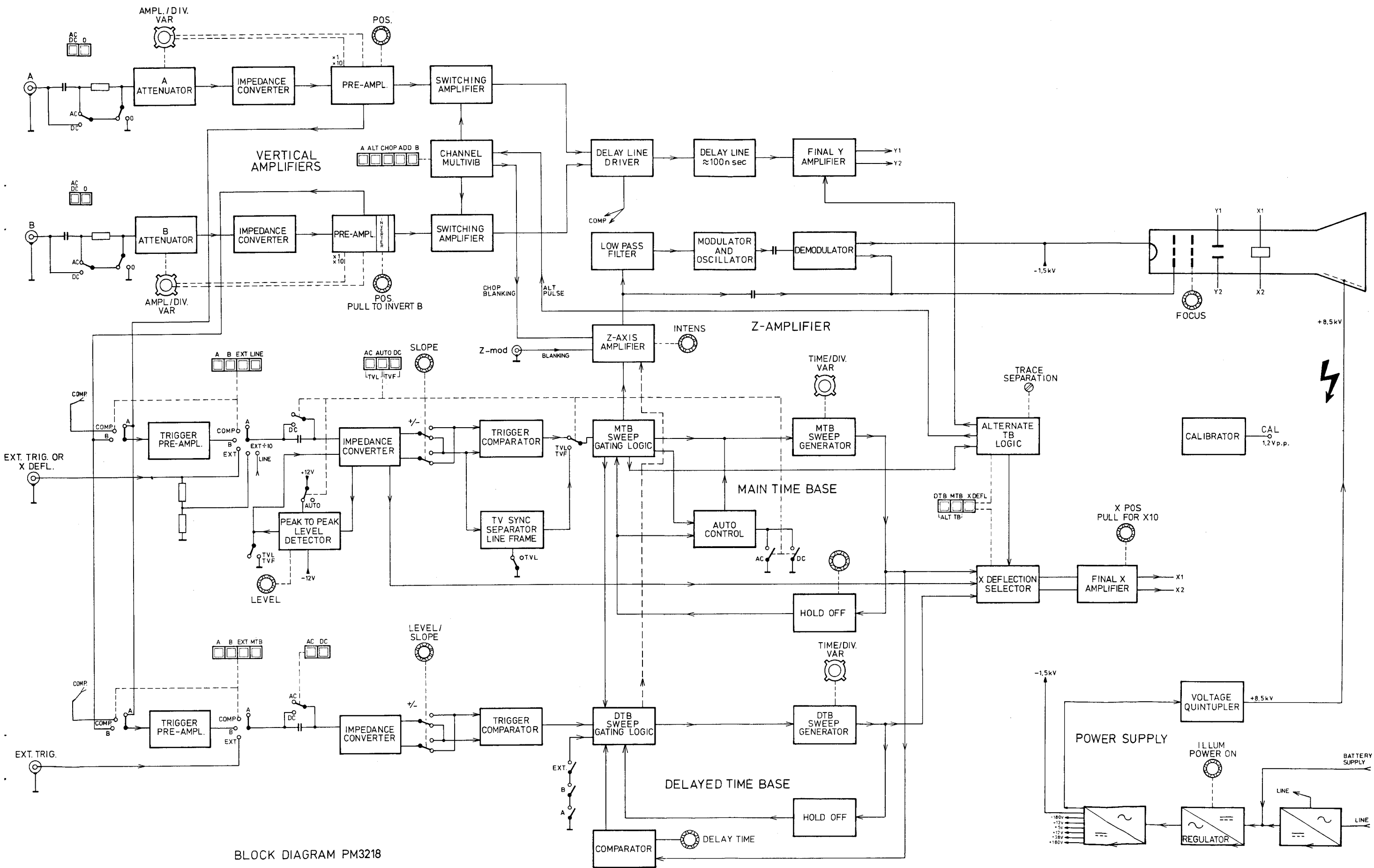
|                                 |                                 |  |
|---------------------------------|---------------------------------|--|
| Operation                       | Automatic                       | Possibility of automatic free-running in the absence of triggering signals |
|                                 | Triggered                       |  |
| Time coefficients               | 0,5 s/DIV ..... 0,1 $\mu$ s/DIV | 1-2-5 sequence   |
| Continuous control range        | 1 : $\geq$ 2,5                  |  |
| Coefficient error               | $\pm$ 3%                        | $\pm$ 5% including x10 magnifier   |
| Magnification                   | 10x                             |  |
| Max. effective time coefficient | 10 ns/DIV                       |  |

### 1.2.5 Delayed time base

|                                 |  |                |
|---------------------------------|--|----------------|
| Operation                       | Delayed time base either starts immediately after delay time or is triggerable after the delay time, by the selected delayed time base trigger source          |                |
| Time coefficients               | 1 ms/DIV – 0,1 $\mu$ s/DIV   | 1-2-5 sequence |
| Continuous control range        | 1 : $\geq$ 2,5   |                |
| Coefficient error               | $\pm$ 3%   |                |
| Delay time                      | In steps variable with main time base.<br><br>Continuously variable with 10-turn potentiometer between 0 x and 10 x the time coefficient of the main time base |                |
| Incremental delay time accuracy | 0,5%   |                |
| Delay time jitter               | 1 : $\geq$ 20.000  |                |

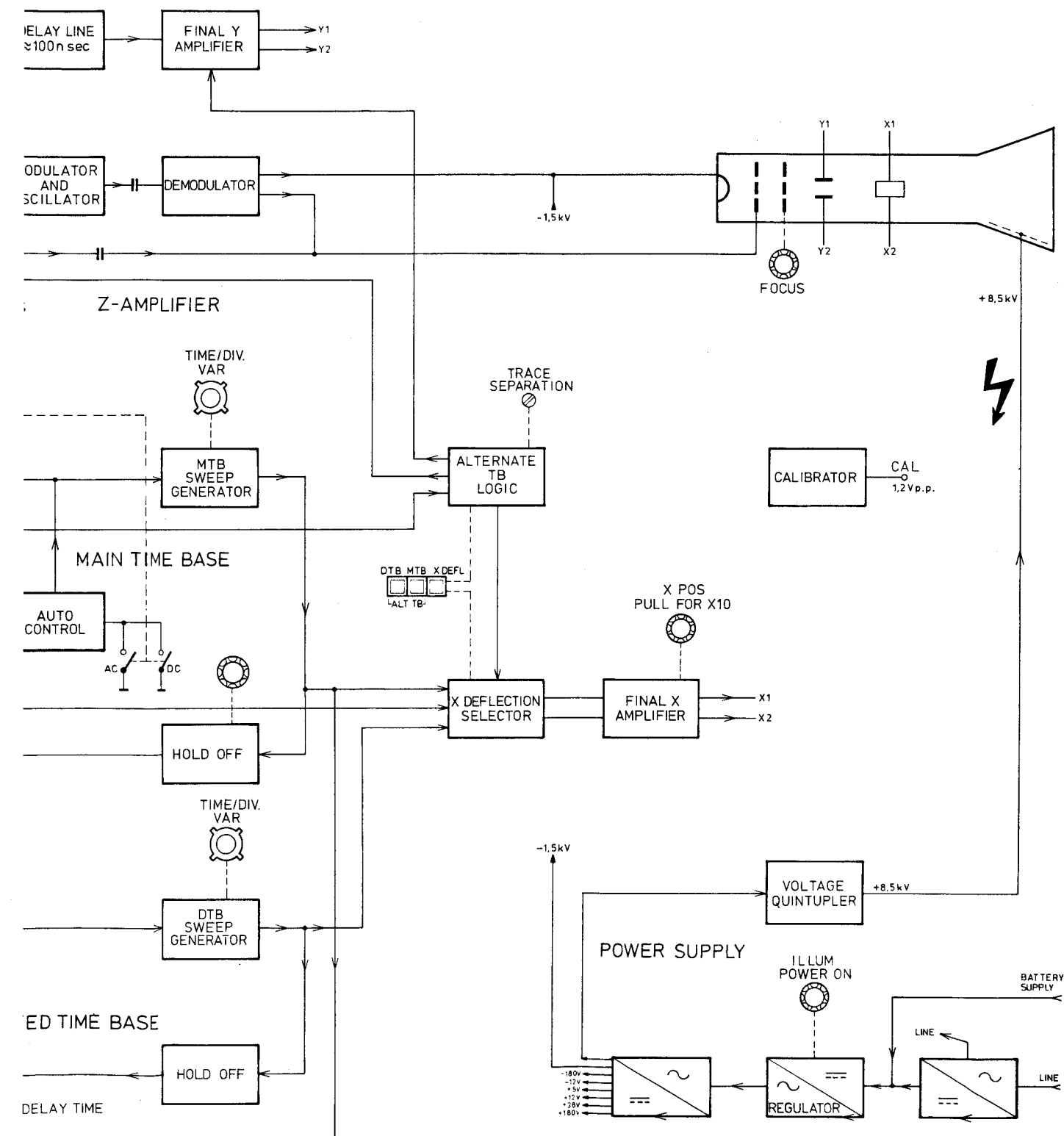
| <i>Designation</i>   | <i>Specification</i>   | <i>Additional information</i>   |
|--|--|---|
| <b>1.2.6 X Deflection</b>  |  |   |
| Source   | A, B, EXT, EXT ÷ 10 or LINE  | As selected by trigger source switch, if push-button X DEFL. is depressed                               |
| Deflection coefficients  | A or B: As selected by<br>AMPL/DIV<br>EXTERNAL : 0,2 DIV<br>EXT ÷ 10 : 2V/DIV<br>LINE 8 divisions at nominal line voltage.   |   |
| Deflection accuracy  | ± 10%  |   |
| Frequency range  | DC: 0..... 1 MHz (-3 dB)<br>over 6 divisions   |   |
| Phase shift  | ≤ 3° at 100 kHz  |   |
| Dynamic range  | 24 divisions   | For frequencies ≤ 100 kHz   |
| <b>1.2.7 Triggering of the main time base</b>  |  |   |
| Source   | Ch. A, Ch. B, Composite,<br>External ÷ 10 and line   |   |
| Trigger mode   | Automatic, normal AC<br>normal DC, TV-line<br>and TV frame   |   |
| Trigger sensitivity  | Internal: 0,5 div (DC ..... 5 MHz)<br>1 div (DC ..... 50 MHz)<br>External : 150 mV (DC ..... 5MHz)<br>200 mV (DC ..... 50MHz)<br>Ext. ÷ 10 : 1,5V (DC ..... 5MHz)<br>2V (DC ..... 50MHz) |   |
| Triggering frequency range   | AUTO: 20 Hz..... ≥ 50 MHz<br>AC: 5 Hz..... ≥ 50 MHz<br>DC: 0 Hz..... ≥ 50 MHz  |   |
| Level range  | AUTO: Proportional to<br>peak-to-peak value of<br>trigger signal.<br>AC, DC: 16 div. at Internal<br>trigg., 3,2 V at external<br>trigg., and 32V at ext. ÷ 10                            | + or -8 div and<br>+or -1,6V referenced to centre of screen<br>+ or -16V referenced to centre of screen |
| Triggering slope   | Positive or negative going   |   |
| Input impedance  | 1 MΩ//20 pF  |   |
| Maximum permissible input voltage  | 400 V, d.c. + a.c. peak  |   |
| Hold-off time  | variable   |   |
| <b>1.2.8 Triggering of the delayed time base</b>   |  |   |
| Source   | chA, chB, Composite,<br>External, MTB.   |   |
| Other trigger specifications are identical to "triggering of the main time base" with the exception of the trigger modes EXT. ÷ 10, TV and AUTO. |  |   |
| <b>1.2.9 Calibration generator</b>   |  |   |
| Output voltage   | 1,2 Vpp  | Square wave   |
| Accuracy   | ± 1%   |   |
| Frequency  | ≈ 2 kHz  |   |

| <i>Designation</i>  | <i>Specification</i>  | <i>Additional Information</i>  |
|---|---|--|
| <b>1.2.10 Power supply</b>  |   |  |
| AC supply:  | Double insulated  | Safety class II, IEC 348   |
| Nominal voltage range (on line-mains voltage adaptor)   | 110, 127, 220 or 240 Vac<br>± 10%   |  |
| Nominal frequency range   | 50 ..... 400 Hz ± 10%   |  |
| Power consumption   | 30 W max.   | At nominal mains voltage   |
| DC supply:  |   |  |
| Voltage range   | 22-27 V dc<br>20-28 V   | Floating input<br>with relaxed specifications  |
| Current consumption   | 1,1 A max.  |  |
| Capacity to earth   | 185 pF<br><br>27 pF   | Measured with rubber feet on grounded metal plate of 1 m <sup>2</sup><br><br>Measured 30 cm above grounded plate of 1 m <sup>2</sup> |
| <b>1.2.11. Environmental characteristics</b>  |   |  |
| The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, THE NETHERLANDS. |   |  |
| Ambient temperatures :  |   |  |
| Rated range of use  | + 5°C ... +40°C   |  |
| Operating   | -10°C ... +55°C   |  |
| Storage and transport   | -40°C ... +70°C   |  |
| Altitude:   |   |  |
| Operating to  | 5000 m (15000 ft)   |  |
| Non-operating to  | 15000 m (45000 ft)  |  |
| Humidity  | 21 days cyclic damp heat 25°C -40°C, R.H. 95%   |  |
| Shock   | 30 g: half sinewave shock of 11ms duration: 3 shocks per direction for a total of 18 shocks   |  |
| Vibration   | Vibrations in three directions with a maximum of 15 min. per direction, 5 - 55 Hz and amplitude of 0.7mm <sub>pp</sub> and 49 max. acceleration.<br>Unit mounted on vibration table without shock absorbing material. |  |
| Electromagnetic interference  | Meets VDE 0871 and VDE 0875 Grenzwertklasse B.  |  |
| Safety  | The isolation between the oscilloscopes and line fulfills the safety requirements of IEC 348 for metal encased class II instruments.  |  |
| <b>1.2.12 Mechanical data</b>   |   |  |
| Dimensions:   |   |  |
| Length  | 445 mm  | Handle and controls excluded   |
| Width   | 335 mm  | Handle excluded  |
| Height  | 137 mm  | Feet excluded  |
| Weight  | 8,4 kg (18,5 lb) approx.  |  |
| <b>1.2.13. Z-mod input TTL compatible "0" blanks display "1" normal intensity see chapter 3.6.</b>  |   |  |



BLOCK DIAGRAM PM3218

Fig. 1.3. Block diagram



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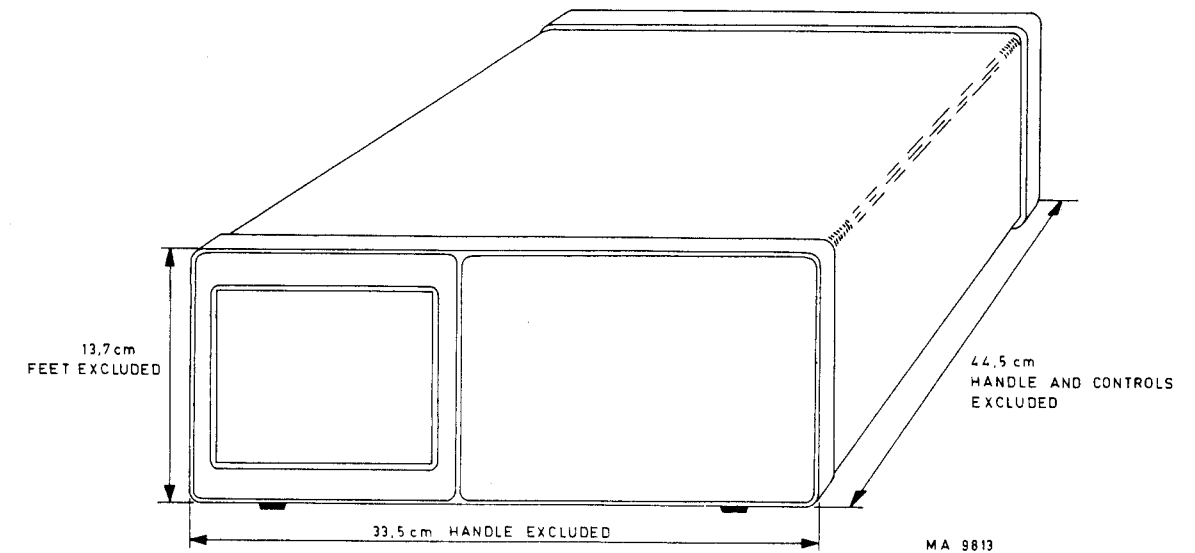


Fig. 1.2. Dimensions

### 1.3. ACCESSORIES

#### 1.3.1. Supplied with the instrument

Front cover  
2 BNC 4 mm adaptor  
2 Probes  
Instruction manual

#### 1.3.2. Optional

|                   |  |
|-------------------|--|
| PM 8925           | Passive probe set 10 : 1 (1.5 m) 40 MHz        |
| PM 8925L          | Passive probe set 10 : 1 (2.5 m) 40 MHz        |
| PM 8921           | Passive probe set 1 : 1 (1.5 m) 15 MHz         |
| PM 8921L          | Passive probe set 1 : 1 (2.5 m) 15 MHz         |
| PM 8940           | Isolation amplifier                            |
| PM 8943           | 1 : 1, 10 : 1 and 100 : 1 650 MHz FET-probe    |
| PM 9355           | Current probe                                  |
| PM 8910           | Polaroid anti-glare filter                     |
| PM 9380           | Oscilloscope camera                            |
| PM 8971           | Camera adaptor                                 |
| PM 8962           | 19" Rack mount adaptor                         |
| PM 9366           | Collapsible viewing hood                       |
| PM 8980           | Closed long type viewing hood                  |
| PM 8901           | Rechargeable battery pack 330 V d.c./24 V d.c. |
| PM 8991           | Trolley  |
| PM 8992/01        | Accessory pouch                                |
| Trimming tool kit |  |

See also Chapter 3.5. "INFORMATION CONCERNING ACCESSORIES".

## 1.4. BLOCK DIAGRAM DESCRIPTION (Fig. 1.3.)

### 1.4.1. Y Channel

The vertical channels A and B for the signals to be displayed are identical, each comprising an input coupling switch, an input step attenuator, an impedance converter and a preamplifier with trigger pick-off.

A channel multivibrator, controlled by the display mode pushbuttons, switches either channel A or channel B to the final Y amplifier via the delay line. The channel multivibrator is operated by a pulse at the end of the sweep, and offers an uninterrupted display of the A and B waveforms in the ALT mode. In the ADD position, both switching amplifiers couple the signals through, thus adding channels A and B. By inverting the B channel amplifier (PULL TO INVERT B) the A - B mode is obtained.

The AMPL/DIV switches provide x 1 or x 10 gain control of the preamplifier, which offers in conjunction with the step attenuator a full range of deflection coefficients in a 1-2-5 sequence.

### 1.4.2. Main time base triggering

To initiate sweeps, trigger signals can be derived from the A and B vertical channel preamplifiers, from an external source, or internally from the mains supply (LINE triggering) as selected by the trigger source switch. Composite triggering (A and B depressed) is derived from the delay-line driver stage. The polarity of the trigger signal, negative or positive-going, on which the display will start is determined by changing the output polarity of the impedance converter.

With the AUTO switch depressed, the peak-to-peak level detector comes into operation. The peak-to-peak level of the signal then determines the range of the LEVEL control.

With AC or DC depressed, the range of the LEVEL control is fixed.

In the TVL and TVF modes the LEVEL control is inoperative and the TV sync separator is switched into circuit, thus initiating sweeps with line or frame pulses depending on the setting of the TVL and TVF switches.

### 1.4.3. Main time base circuit

For normal internal time base operation the horizontal amplifier is fed by sweeps from the time base circuit. With AUTO depressed, in the absence of trigger signals, the output of the sweep generator is fed back via the hold-off circuit and gate to its input. This causes sweeps to free-run and a resultant trace is displayed on the screen. As soon as the AUTO control circuit detects a trigger (i.e. a change in the output of the sweep-gating logic) the sweep is fed back to the sweep-gating logic. This causes the circuit to revert to the normal triggering mode in which sweeps are initiated only by trigger pulses at the input of the sweep-gating logic.

With AC or DC depressed, AUTO control is made inoperative. Sweeps are then only produced provided a trigger signal is present and the LEVEL control appropriately set.

The display can be magnified in the horizontal direction by increasing the gain of the final amplifier by a factor of x10 (also the X DEFL mode).

When the X DEFL pushbutton of the horizontal selection switch is depressed, the sweep generator output to the final amplifier is inhibited and the impedance converter is connected directly to the final amplifier. In this way, the signals normally selected for triggering, or an external source, can now be used for horizontal deflection.

### 1.4.4. Hold-off circuit

The hold-off stage, as its name implies, "holds-off" triggers from the input of the time base circuit until the trace has completely returned and the time base circuits are completely reset. The hold-off time can be decreased by turning the HOLD-OFF control clockwise.

### 1.4.5. Z Axis

The Z amplifier provides for the blanking of the trace during the fly-back and hold-off time. In addition, it blanks the sweep in the CHOP mode during the switching transients. More over the trace can be blanked by a signal applied to the external Z-mod input. The l.f. components of the blanking signal are modulated and demodulated before they are applied to the Wehnelt cylinder together with the a.c. coupled h.f. components.



#### 1.4.6. Delayed time base triggering

To initiate sweeps, trigger signals can be derived from the A and B vertical channel preamplifiers, or from an external source as selected by the trigger source push button switch.

With both the A and B pushbuttons depressed simultaneously, composite triggering is derived from the delay-line driver stage of the Y amplifier channel. AC and DC coupling is provided to the impedance converter. The polarity of the trigger signal, negative or positive-going, on which the display will start, is determined by changing the output polarity of the impedance converter by the SLOPE switch.

With MTB selected, the delayed time base starts directly after the delay time. The DELAY TIME control in conjunction with the comparator determines the delay time for the delayed time base generator.

#### 1.4.7. Delayed time base circuit

The delayed time base is operative unless its TIME/DIV switch is in the OFF position. It starts immediately after the delay time, or upon receipt of the first trigger pulse after the delay time.

The sawtooth signal derived from the main time base sweep generator is passed to a comparator where it is compared with an accurately adjustable d.c. voltage, controlled by the DELAY TIME control.

The comparator output is pulse-shaped and provides the required delay pulse for the sweep-gating logic of the delayed time base generator. A sawtooth voltage is then initiated.

The delayed sweep is reset by the hold-off circuit of the delayed time base (end of the sweep detection) or by the main time base.

It can be started again by the output signal of the comparator after the initiation of the next main time base sweep.

When pushbutton MTB of the horizontal deflection mode controls is selected, the part of the trace coinciding with the delayed sweep is intensified.

#### 1.4.8. Alternate time base logic

In ALT TB mode an electronic switch enables main time base display and delayed time base display to be alternately traced on the screen.

The two displays can be separated by varying the voltage applied to the vertical amplifier, derived from the driving circuits of the electronic switch. This separation is symmetrically variable by means of the TRACE SEPARATION control on the front panel.

In the ALT TB mode the vertical channel multivibrator is controlled by a signal derived from the electronic switch.

In the vertical and horizontal ALT modes, successively are displayed on the screen, Channel A and main time base, Channel A and delayed time base, Channel B and main time base, Channel B and delayed time base.

#### 1.4.9. Power supply

The mains (line) supply is transformed and rectified before being applied to a d.c. to a.c. converter.

When the instrument is operated from a battery supply, the battery output is connected directly to the d.c. to a.c. converter.

The output of the regulator is coupled to a transformer and rectifier which, after rectification, provides the  $-1.5$  kV potential and the circuit supply voltages. The  $-1.5$  kV is also multiplied to 8.5 kV to supply the required total accelerating voltage of  $\approx 10$  kV.

## 2. Directions for use

### 2.1 INSTALLATION

#### 2.1.1 Safety regulations (in accordance with IEC 348)

Before connecting the instrument to the mains (line), visually check the cabinet, controls and connectors etc. to ascertain whether any damage has occurred in transit. If any defects are apparent, do not connect the instrument to the mains (line).

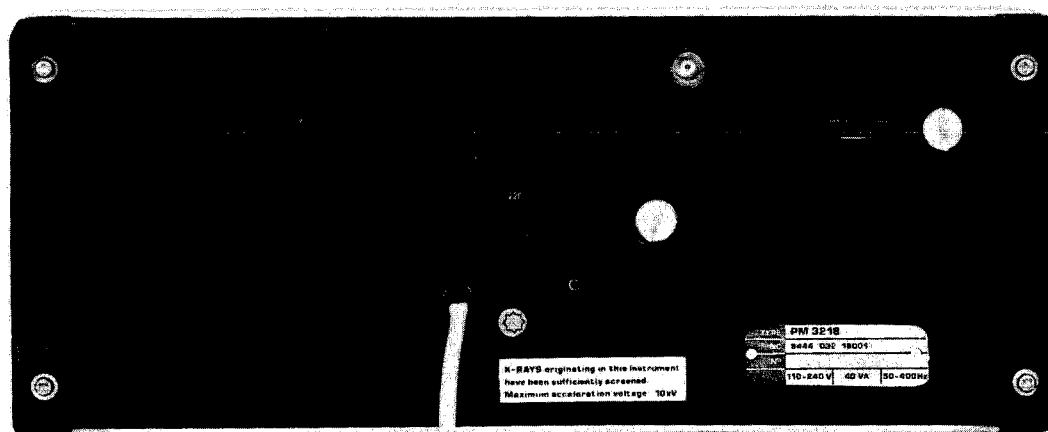
The instrument must be disconnected from all voltage sources and any high voltage points discharged before any maintenance or repair work is carried out. If adjustments or maintenance of the operating instrument with covers removed is inevitable, it must be carried out only by a skilled person who is aware of the hazards involved. In normal operation the double-insulated power supply obviates the need of a safety ground.

**Warning:** It must be borne in mind that in all measurements the frame ground of the oscilloscope is raised to the same potential as that of the measuring ground probe connection. Neither the probe's ground lead nor the frame ground shall be connected to live potentials.

#### 2.1.2 Local mains (line) connection and fuse protection

Before connecting the instrument to the mains (line) ensure that it is set to the local mains (line) voltage. On delivery the instrument is set to 220 V. If the instrument is to be used with 110 V, 127 V or 240 V supply, the appropriate voltage should be selected by turning the adaptor on the rear panel to indicate the voltage required (see Fig. 2.1).

The instrument is protected from overloads by a thermal fuse fitted between the mains (line) transformer windings. It can be replaced after having removed the instrument rear panel (see section 2.4.)



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Fig. 2.1. Rear view of the oscilloscope showing the voltage adapter set to 220 V.

### 2.1.3 Connection to an external supply

An external supply or battery of 22 V to 27 V capable of delivering at least 1 A can be connected to the socket on the rear panel. (DC Power input cord set: 4822 321 20125).

The inner conductor must be connected to the negative pole and the outer conductor to the positive pole, as indicated on the rear panel.

The instrument is protected against overloads and reversed polarity by an internal fuse and diode. This fuse can be replaced after having removed the instrument rear panel (see section 2.4.).

### 2.1.4 Front cover and instrument position

The front cover can be simply removed by pulling it from the front.

The instrument may be used horizontally or in several sloping positions by using the carrying handle as a tilting bracket.

To unlock the handle, simultaneously push in both pivot centre knobs.

## 2.2 CONTROLS AND SOCKETS (Refer to Fig. 2.2)

### 2.2.1 Cathode-ray tube and POWER controls

ILLUM  
POWER ON

Continuously variable control of the graticule illumination; incorporates mains (line) switch. POWER ON pilot lamp indicates the ON state.

INTENS

Continuously variable control of the trace brilliance.

FOCUS

Allows beam to be focused for minimum spot size.

TRACE ROTATION

Screwdriver adjustment to align the trace with the horizontal graticule lines.



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Fig. 2.2. Front view of the oscilloscope showing controls and sockets.

## 2.2.2 Vertical channels

### *Display mode switch*

A — ALT — CHOP — ADD — B

A

ALT

CHOP

ADD

B

POSITION

PULL TO INVERT B

AMPL/DIV (outer-knob)

AMPL/DIV (centre-knob)

### *Input coupling switch*

AC/DC — 0

AC (depressed)

DC (released)

0 (depressed)

A (1M $\Omega$ //20pF)

B (1M $\Omega$ //20pF)

### *Function*

5-way pushbutton switch selecting the vertical display mode. With all buttons released, the ALT mode is in operation.

Vertical deflection is achieved by the signal connected to the input of channel A.

The display is switched over from one vertical channel to the other at the end of every cycle of the timebase signal.

The display is switched over from one vertical channel to the other at a fixed frequency. ( $f \approx 500$  kHz)

Vertical deflection is achieved by the sum signal of channels A and B.

Vertical deflection is achieved by the signal connected to the input of channel B.

Continuously variable controls giving vertical shift of the display.

Push-pull switch combined with the channel B POSITION control. When pulled, channel B signal is inverted.

Step control of the vertical deflection coefficients, ranging from 2 mV/div up to 10 V/div in a 1-2-5 sequence.

Continuously variable control of the vertical deflection coefficients. Note that the deflection coefficient is calibrated only with the centre-knob switched to the CAL position (fully-clockwise).

Signal coupling; 2-way pushbutton switch

Coupling via a blocking capacitor

Direct coupling

Connection between input circuit and input socket is interrupted and the input circuit is grounded.

BNC socket for channel A input

BNC socket for channel B input

## 2.2.3 Horizontal channel

### *X deflection source switch*

DTB                      MTB — XDEFL  
└─ ALT TB ─┘

DTB

MTB

### *Function*

Horizontal-deflection controls; 3-way pushbutton switch

The horizontal deflection voltage is supplied by the delayed timebase generator.

The horizontal deflection voltage is supplied by the main timebase generator. A portion of the trace is intensified when the delayed timebase is running.

The delayed timebase generator is switched off when the DELD TIME/DIV switch is in the OFF position.

If no buttons are depressed the effect is the same as the MTB button depressed (only the MTB LEVEL control is not operating in this situation).

When both the DTB and MTB pushbuttons are selected simultaneously, the horizontal deflection voltage is supplied by the main and delayed timebases alternately.

DTB                      MTB  
└─ ALT TB ─┘

X DEFL

Horizontal deflection is achieved by the channel A signal, the channel B signal, the mains frequency signal or an external signal applied to the external input socket of the main time base.

X POS/X MAGN

Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch, PULL FOR x 10, which increases the horizontal deflection coefficient by a factor of 10. The magnifier is also operative if an external X deflection signal is used.

TRACE SEP

Continuously variable control of the vertical space between the two time-base displays in the ALT.TB mode.

#### 2.2.4 Main time base generator

LEVEL

SLOPE (IN +, OUT-)

Continuously variable control to select the level of the triggering signal at which the timebase generator starts.

This control incorporates a push-pull switch, which enables choice of triggering on the positive or negative-going edge of the triggering signal. For TV triggering, select – for negative video signals and + for positive video signals.

*Trigger mode switch**Function*

AC – AUTO – DC

└ TVL ┘ └ TVF ┘

3-way pushbutton switch selecting the trigger mode.

With all pushbuttons released AUTO sweep mode is in operation at a fixed range of the LEVEL control.

AUTO

A trace is displayed in the absence of trigger signals. The range of the LEVEL control is proportional to the peak-to-peak value of the triggering signal.

AC

Normal triggering and fixed range of the LEVEL control. The DC component of the trigger signal is blocked.

DC

Normal triggering and fixed range of the LEVEL control. The DC component of the trigger signal is passed.

AC AUTO

└ TVL ┘

Line synchronisation is obtained.

AUTO DC

└ TVF ┘

Frame synchronisation is obtained.

HOLD OFF

Continuously variable control of hold-off time

*Trigger source switch**Function*

A – B-EXT – EXT÷10

└ COMP ┘ └ LINE ┘

4-way pushbutton switch selects the trigger source, (or the source of horizontal deflection if X deflection source switch is depressed for X DEFL).

With all pushbuttons released, the effect is the same as the A button depressed.

A

Signal derived from channel A

B

Signal derived from channel B

A B

└ COMP ┘

Composite signal, derived after the electronic switch. Triggering occurs on the displayed waveforms (not usable with X DEFL).

EXT and EXT÷10

External signal derived via the adjacent 1 M $\Omega$ //20pF socket.

LINE (MAINS)

Signal derived from the line (mains) voltage. (Inoperable when instrument is battery-powered).

TIME/DIV (outer switch)

Selects the time coefficient from .1  $\mu$ s/div to .5 s/div in a 1-2-5 sequence.

TIME/DIV (inner knob)

Continuously variable control of the time coefficients. Must be switched to CAL position (i.e. fully clockwise) for the time axis to be calibrated according to the indication of the TIME/DIV switch.

1 M $\Omega$  – 20 pF

BNC socket for external triggering or horizontal deflection.

### 2.2.5 Delayed time base generator

LEVEL  
SLOPE (IN +, OUT -)

Continuously variable control to select over a fixed range the level of the triggering signal at which the time base generator starts. This control incorporates a push-pull switch, which enables choice of triggering on the positive or negative going edge of the triggering signal.

#### *Trigger mode switch*

AC — DC

#### *Function*

2-way pushbutton switch selecting the trigger mode

AC

Normal triggering and fixed range of the LEVEL control. The DC component of the trigger signal is blocked.

DC

Normal triggering and fixed range of LEVEL control. The DC component of the trigger signal is passed.

DELAY TIME

Continuously variable vernier control of the delay time, together with the TIME/DIV controls of the main time base generator.

#### *Trigger source switch*

A — B — EXT — MTB

#### *Function*

4-way pushbutton switch selects the trigger source and starting point of delayed time base. No pushbutton depressed has the same effect as the MTB button depressed.

└COMP┐

A

Internal triggering

Signal derived from channel A.

B

Internal triggering

Signal derived from channel B.

A        B  
└COMP┐

Composite signal, derived after the electronic channel switch.

Triggering occurs on the displayed waveform, after selected delay time.

EXT

Triggering on an external signal connected to the adjacent 1M $\Omega$ //20pF socket.

MTB

Internal triggering signal derived from the main time base to start the delayed time base immediately after the selected delay time.

TIME/DIV (outer switch)

Selects the time coefficient from .1  $\mu$ s/div to 1 ms/div in a 1-2-5 sequence. Incorporates an OFF position by which the delayed time base generator is switched off.

TIME/DIV (inner knob)

Continuously variable control of the time coefficients. Must be in the CAL position (i.e. fully clockwise) for the time axis to be calibrated according to the indication of the TIME/DIV switch.

1M $\Omega$  — 20 pF

BNC socket for external triggering signal.

### 2.2.6 Miscellaneous

CAL

Output socket supplying squarewave voltage  $\approx 2$  kHz at an amplitude of 1.2 V p-p  $\pm 1\%$ . To be used for probe compensation and/or checking vertical deflection accuracy.

DC POWER IN

Input socket at the rear of the instrument allows operation by an external d.c. supply. Rated supply voltage 22 V to 27 V, current capability  $> 1$ A.

LINE (MAINS) VOLTAGE  
ADAPTOR

Must be set according to section 2.1.2 before the instrument is connected to the local mains voltage.

Z-MOD

See chapter 3.6.

## 2.3 OPERATING INSTRUCTIONS

### 2.3.1 Switching on the instrument

Before connecting the instrument to any supply, the instructions given in section 2.1 Installation, should be carefully carried out.

The oscilloscope will meet specifications (see section 1.2) normally after a warming-up period of approximately 15 minutes. However, if the instrument has been subjected to an extremely cold environment (e.g. left in a car overnight in freezing conditions) and is then brought in for use in a warm room, a warming-up period of sufficient length should be allowed (see 1.2.11).

### 2.3.2 Preliminary settings of the controls

This procedure is a general indication of whether the oscilloscope is functioning correctly and provides a suitable starting point before any measurements are made.

Refer to Fig. 2.2 for location of controls.

Set INTENS and FOCUS controls in mid position.

Depress AUTO and select an average time coefficient between 10  $\mu$ s/div and 10 ms/div with the TIME/DIV switch. With all other pushbuttons normal (not depressed) channel A and channel B traces can be positioned on the screen with the relevant POSITION controls. Set the INTENS control for a display of medium brightness and adjust FOCUS control for well focused traces.

### 2.3.3 Input coupling (AC/DC, 0)

**AC coupling** (pushbutton depressed) is useful to block the d.c. component of a signal. Choice of AC limits the lower frequencies, causing low repetition rate sinewave signals to be attenuated and low repetition rate squarewaves to be distorted. The degree of attenuation is determined by the input RC time (0.1s). Input RC time is extended by 10 if 10:1 passive probes are employed.

When switching to AC coupling it will take approximately five input RC times before the trace is stabilised to the average value of the input signal.

AC position measurements cannot be made with respect to ground.

**0 position** disconnects input source and short-circuits input of amplifier to provide zero signal check.

**DC coupling** (pushbutton released) provides for full range frequency input, i.e. down to d.c.

### 2.3.4 Use of probes

1:1 passive probes should only be used for d.c. and low frequencies.

Capacitive loading attenuates high frequencies or increases the rise-time of measurement signals (dependent on source impedance).

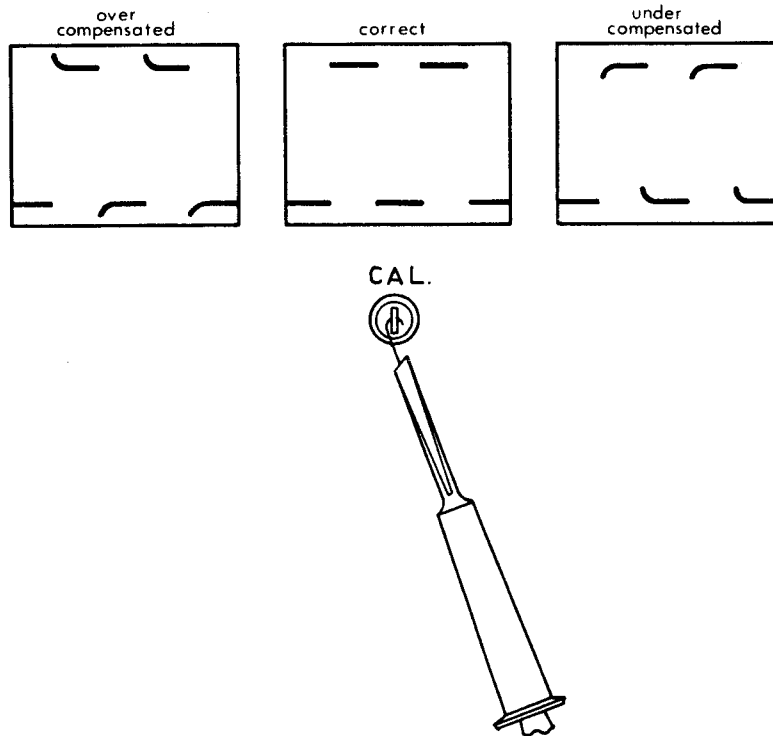
10:1 passive probes have less capacitive loading; usually about 10pF to 20pF. FET probes are superior, especially when measurements are to be taken from high impedance test points or at the upper frequency limit of the oscilloscope bandwidth.

10:1 passive probes must be properly compensated before use. Incorrect compensation leads to pulse distortion or amplitude errors at high frequencies.

For correct adjustment, the CAL output connection can be used (see Fig. 2.3.)

### 2.3.5. Adjustment of attenuator probes

- Connect the compensation box to socket A and place the tip of the probe on socket CAL.
- Insert a small screwdriver through the hole in the compensation box and adjust the trimmer to obtain a correct display as shown in Fig. 2.3.



MA 8329

Fig. 2.3. Adjusting an attenuator probe

### 2.3.6. Selection of chopped or alternate modes

(A ALT CHOP ADD B)

In dual channel operations (CHOP or ALT depressed) the chopped mode (depress CHOP) must be selected for relatively slow sweep speeds (from .1 ms/div to .5 s/div) or at low repetition rates of sweeps occurring, even at high sweep rates. Selection of the ALTErnate mode under these circumstances would make comparisons between waveforms difficult because traces would actually appear to be written one by one. However, when the display is fast enough to be interrupted by the chopping frequency the alternate mode must be selected (depress ALT), usually at sweep rates faster than .1 ms/div.



### 2.3.7. Differential mode

The A — B mode can be selected by depressing ADD and pulling the channel B POSITION control.

In measurements where signal lines carry substantial common mode signals (e.g. hum) the differential mode will cancel out these signals and leave the remainder of interest (A — B). The capability of the oscilloscope to suppress common mode signals is given by the CMR factor (see Fig. 2.4).

To obtain the degree of common mode rejection as specified, channel A and B gains must first be equalised. This can be done by connecting both channels to the CAL output connector, and adjusting one of the continuous controls with the AMPL/DIV switch for minimum deflection on the screen.

When passive 10:1 probes are used a similar equalisation process is recommended by adjusting their compensating controls for minimum deflection.

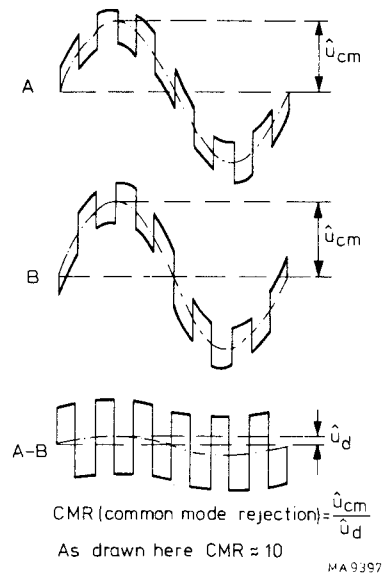


Fig. 2.4. Suppression of common mode signals

### 2.3.8. Selection of trigger mode

(AC AUTO DC)  
 L TVL L TVF L

The AUTO mode is most useful because it provides trace(s) on the screen even in the absence of trigger signals. Furthermore, for a signal amplitude larger than 1 division, this mode provides stable triggering independently of the position of the LEVEL control; its range is automatically adjusted to the peak-to-peak value of the signal selected for triggering.

In this way the setting of the LEVEL control is facilitated at small amplitudes of the trigger signal.

The AUTO mode cannot be employed for signals with low repetition rates (10 Hz or lower) because the sweeps would be able to free run in between triggers. Therefore, for low repetition signals normal triggering must be used (AC or DC depressed).

In normal triggering, sweeps are only initiated with a trigger signal applied and the LEVEL control set appropriately.

With AC or DC depressed the range of the LEVEL control is fixed (+ or —8 divisions or more at the extremes of the LEVEL control with respect to mid screen).

The DC component in the trigger signal can be blocked by depressing AC. This is useful when triggering must take place on a.c. signals superimposed on a large d.c. level.

With AC coupling, the level at which the display starts will change with alterations in the average value of the trigger signal. The trigger level is thus no longer referenced to signal ground. This may cause instability with waveforms that vary in time interval from cycle to cycle. Normally it is preferable to use the DC position.

Slope selection is made with pushbutton +/—. In TV mode — must be selected for negative video signals and + for positive video signals. The LEVEL control is inoperable in the TV mode.

No buttons depressed offers an extra mode of use, a trace is on screen in the absence of a trigger signal, but the LEVEL range is fixed.

### 2.3.9. Trigger sources

The main time base trigger sources can be selected by the front-panel TRIG or X DEFL pushbuttons.



- *Internal triggering* will be most commonly used because it requires only one signal (the input signal) to obtain stable triggering.
- *External triggering*. When tracing many signals it is advantageous to use an external signal for triggering. There is no need to set and reset the trigger controls (LEVEL, SLOPE and SOURCE) on changing the input signal. Furthermore the two A and B inputs remain free for examining waveforms.
- *Selection of trigger source*. In comparing waveforms that are a multiple of each other's frequency, always select the signal, that has the lowest repetition rate as the trigger source. Not doing so may lead to double pictures (chopped mode) or untrue time-shifts (alternate mode).
- *Composite triggering*. With internal triggering signals are obtained from either the A channel, the B channel preamplifier stages or, when COMP is selected by depressing both A and B pushbuttons, from the delay line driver stage that follows the electronic channel switch.

Composite triggering offers three advantages:

1. In differential mode (A – B measurements) triggering is derived from the differential signal. Triggering is not disturbed by common mode signals.
2. For one channel operation it is not necessary to switch trigger sources from A to B or vice versa.
3. In the alternate mode, it is possible to compare signals that are not related in time.

*Note: When composite triggering is employed in dual channel operation (chopped or alternate), and there is only one signal applied (to A or B input), stable triggering cannot be obtained. This is only normal since the trigger source is also switched from A to B (see Fig. 2.5).*

- *Line (mains) triggering* is useful when the signal input is mains (line) frequency related.

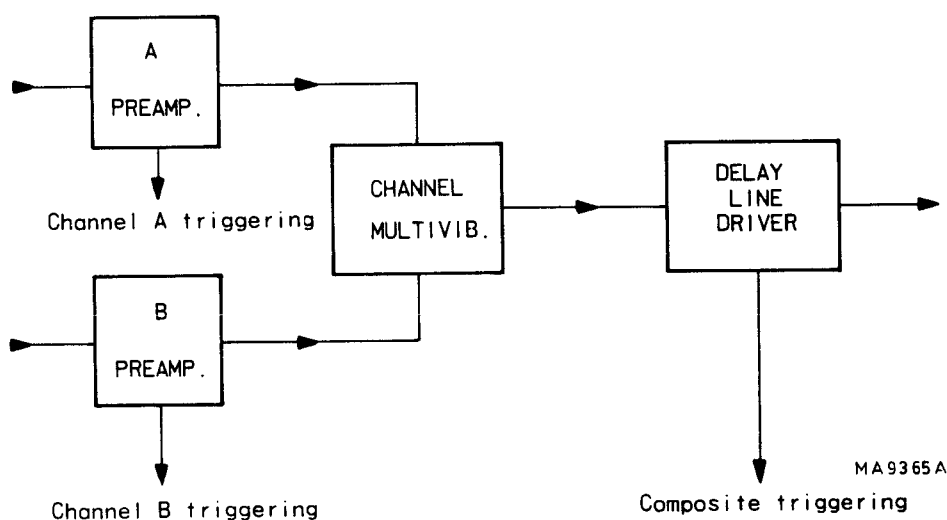


Fig. 2.5. Block diagram of composite trigger circuit

### 2.3.10. Time-base magnifier

The magnifier is operated by pulling the switch incorporated in the X position control.

When this switch is in the x10 position, the time-base sweep speed is increased 10 times. The sweep time is therefore determined by dividing the indicated TIME/DIV value by 10.

### 2.3.11. Hold-off.

This control can be used to increase the sweep hold-off time.

### 2.3.12. XY Measurements

XY measurements are made with the TIME/DIV switch at EXT X DEFL, the source of horizontal deflection being selected by the TRIG or X DEFL pushbutton switch (A, B, EXT, EXT  $\div$  10 or LINE)

XY measurements provide a useful means of making frequency or phase shift comparisons by displaying Lissajous patterns.

Measurements can be made up to 100 kHz with less than 3° phase error between horizontal and vertical channels.

The sensitivity for the different XY modes is shown in the following table:

| X deflection  | Sensitivity          |
|---------------|----------------------|
| A             | AMPL/DIV A $\pm$ 10% |
| B             | AMPL/DIV B $\pm$ 10% |
| EXT           | 0.2 V/DIV            |
| EXT $\div$ 10 | 2 V/DIV              |
| LINE          | 8 divisions          |

### 2.3.13. Using the Delayed time-base

The delayed time base can be used for the accurate study of complex signals. The delayed time base generator starts (TIME/DIV switch not at OFF) after the selected delay time and the delayed signal is intensified when the MTB pushbutton of the horizontal deflection controls has been selected.

The DELAY TIME potentiometer control enables the intensified portion to be shifted along the time axis. The duration of the intensified portion, its length, can be controlled in steps and continuously by means of the TIME/DIV controls of the delayed time base generator. When pushbutton DTB of the horizontal deflection controls is depressed, the intensified portion occupies the full width of the screen.

In the DTB position, the delay time (i.e. the interval between the starting points of the main time base and that of the delayed time base) is determined by the setting of the main time base TIME/DIV controls and the DELAY TIME control. The PM3218 is equipped with display switching. This offers the instrument user a simultaneous display of the signal on the two time scales provided by the main time base and by the delayed time base.

By selecting ALT TB, detailed examination of a certain portion of the main time base display is enabled by expanding the time interval of interest, using the delayed time base.

Expansion is achieved by selecting a correspondingly faster sweep for the delayed time base TIME/DIV control and positioning the time interval by the DELAY TIME potentiometer.

The part of the signal under detailed observation by the delayed time base also remains as an intensified portion of the main time base display. This not only facilitates the location of the required detail during dialling, but also serves as a visual indication of the portion of the overall trace being examined. Selection of ALT TB thus enables immediate correlation of the detail with the overall signal, which may be extremely complex, without the need to switch between MTB and DTB.

## 2.4. PROCEDURES REQUIRED FOR THE REMOVAL OF FUSES, BEZEL AND CONTRAST PLATE

### 2.4.1. Removing the instrument covers

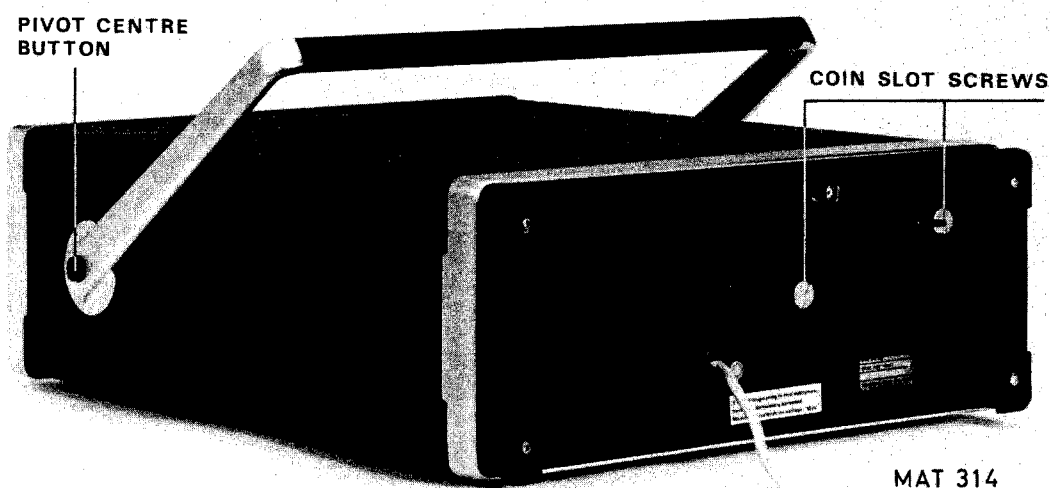
Always ensure that the mains supply is disconnected before removing any instrument cover plates.

The instrument is protected by three covers: a front panel protection cover, a wrap-around cover with carrying handle, and a rear panel.

To facilitate removal of the wrap-around cover and the rear panel, first ensure that the front cover is in position.

Then proceed as follows:

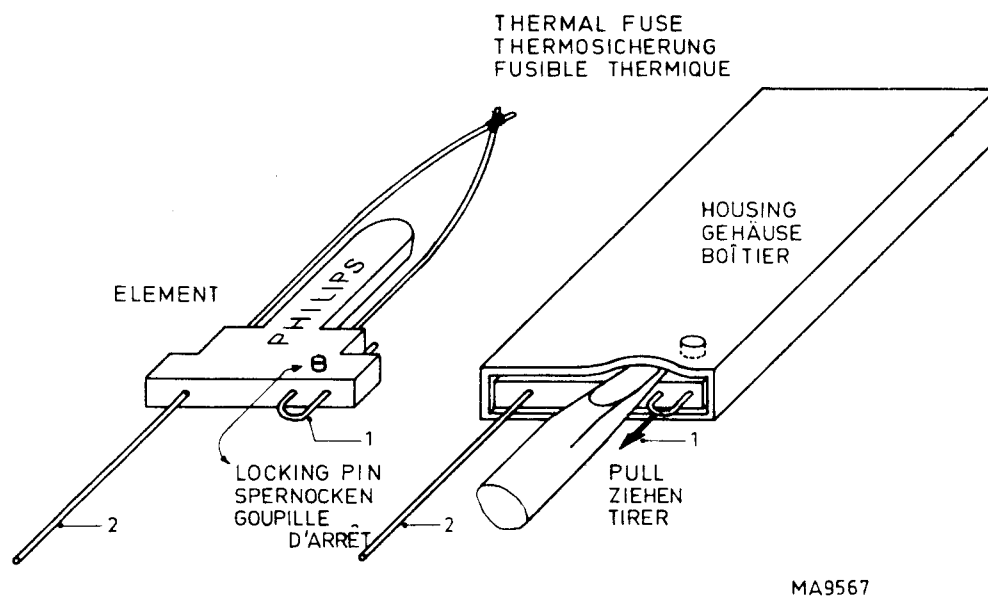
- Hinge the carrying handle clear of the front cover; to this end, push both pivot centre buttons (Fig. 2.6.).
- Stand the instrument on its protective front cover on a flat surface.
- Slacken the two coin-slot screws located on the rear panel.
- Lift the rear panel and unplug the connector on the power supply board.
- Lift off the wrap-around cover.
- For access to the front-panel, stand the instrument horizontally and snap off the front cover.



*Fig. 2.6. Removing the instrument covers*

### 2.4.2. Removing the mains transformer

- Remove wrap-around cover and rear panel (section 2.4.1.).
- Take the lid off the voltage adapter compartment after removing the 4 cross-slotted screws.
- Remove the 4 cross-slotted screws that hold the lid of the transformer compartment.
- Lift the lid with the attached transformer, simultaneously sliding the wire form between transformer and voltage adapter out of the slit in the transformer compartment.
- The transformer and thermal fuse are then accessible for replacement.



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Fig. 2.7. Replacing the thermal fuse

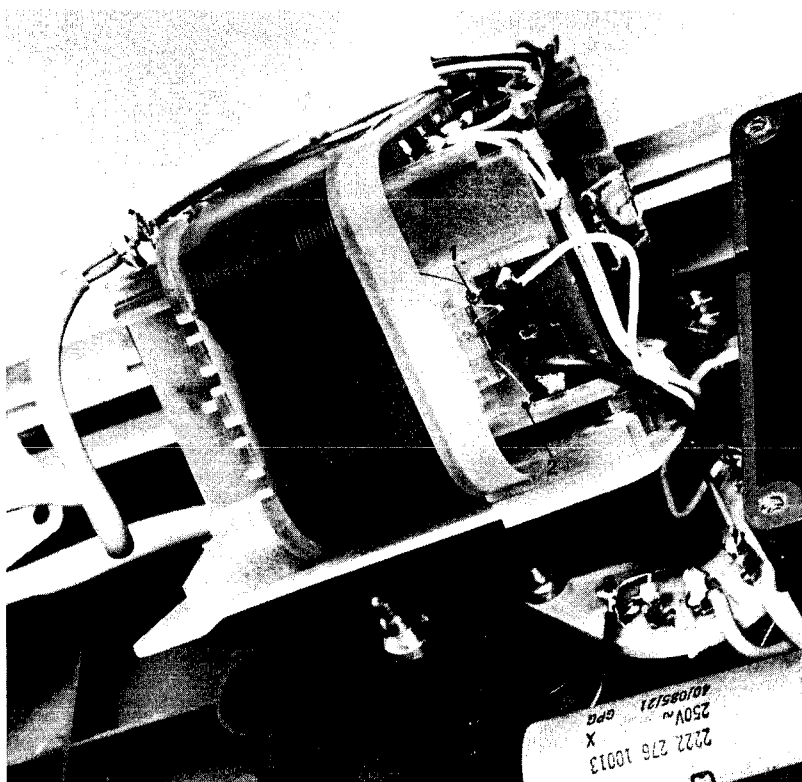


Fig. 2.8. Replacing the thermal fuse

#### 2.4.3. Replacing the thermal fuse F101

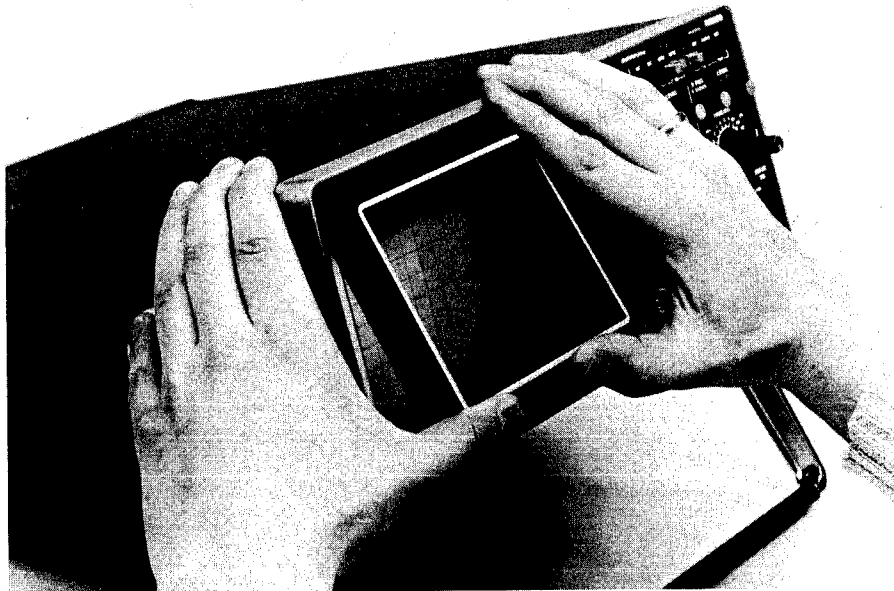
- Remove the mains transformer (section 2.4.2.).
- Unsolder fuse terminals 1 and 2 (Fig. 2.7. and 2.8.).
- Only the fuse wire of the old fuse is replaced and not the complete fuse; to this end, bend the housing of the fuse slightly outwards, disengage the locking pin and pull out the wire.
- Take the new fuse and remove the fuse wire out of its housing in the same way as described above.
- Push the new fuse wire into the housing of the old one until the locking pin snaps into the hole. The loop in the fuse wire must point to terminal 1.
- Solder the fuse wire to terminals 1 and 2.

#### 2.4.4. Replacing the fuse F201

- Remove wrap-around cover and rear panel (section 2.4.1.).
- Fuse F201, which is located on the power supply printed circuit board, is now accessible for replacement.

#### 2.4.5. Removing the bezel and the contrast plate

- Take hold of the bezel's bottom corners and gently pull it from the front panel (Fig. 2.9.).
- The contrast filter can be removed by pressing it gently out of the bezel.



*Fig. 2.9. Removing the bezel and the contrast plate*



### 3.3. INFORMATION FOR ASSISTANCE IN FAULT FINDING

#### 3.3.1. Mains transformer data

The available unloaded voltage tapings and the number of turns per winding are listed in the circuit diagram (Fig. 3.44) in the form of a table.

#### 3.3.2. Voltages and waveforms in the instrument

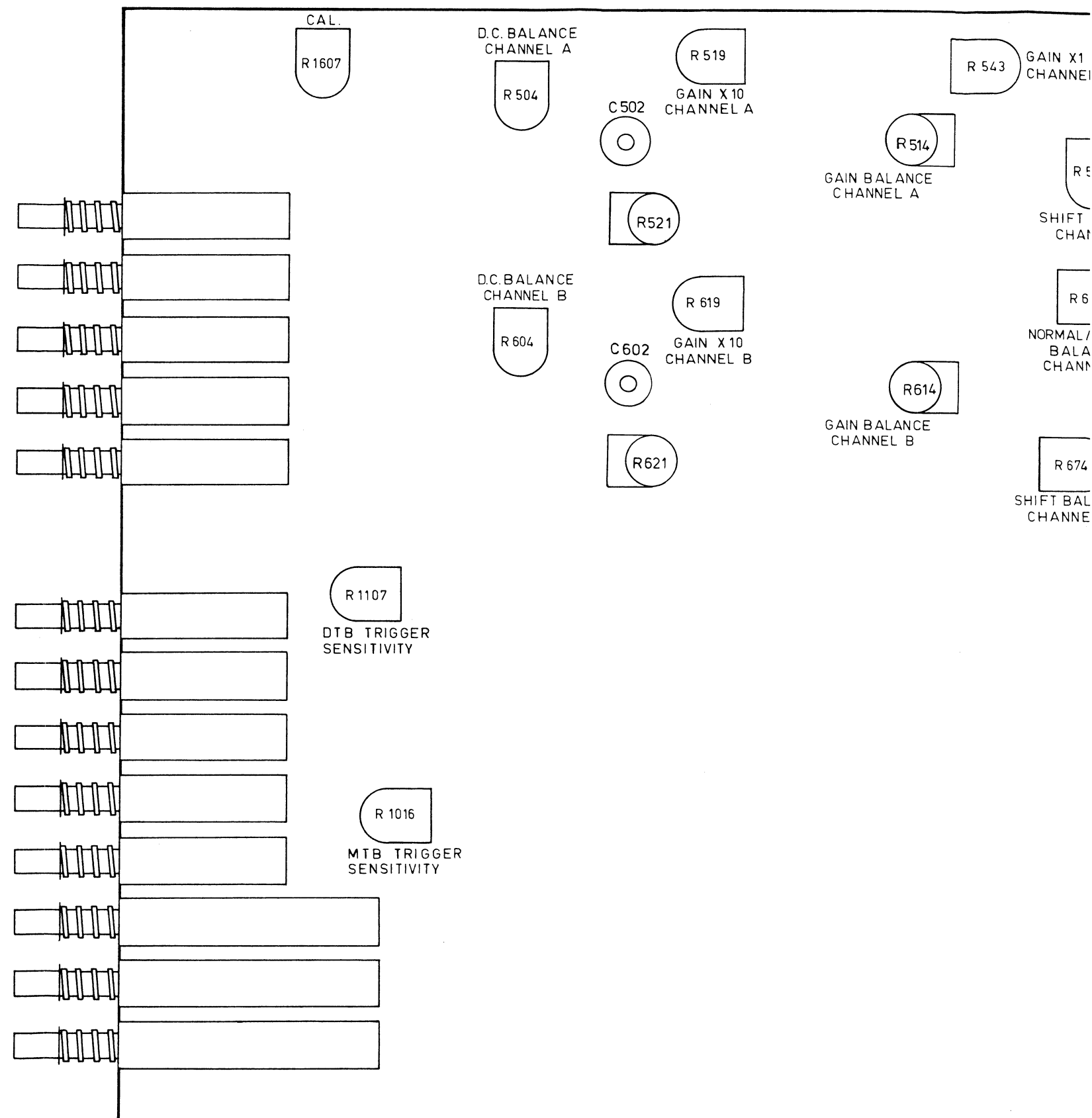
The d.c. voltage levels at the electrodes of the transistors and the voltage waveforms in the time-base generators are shown at the relevant points on the circuit diagrams (Fig. 3.44, Fig. 3.45 and Fig. 3.46). The oscilloscope under test must be set in the following way to measure the voltage wave forms as shown in Fig. 3.44 and Fig. 3.46.

- Display mode switch S1 to position "A".
- X deflection selector switch S3 to position "MTB".
- MTB trigger mode switch S4 to position "AUTO".
- A POSITION potentiometer R2 at mid-range.
- A AMPL/DIV switch S9 to 1 V/div. and potentiometer R9 to CAL.
- Input signal on A input socket X2: 2,5 kHz sine-wave voltage for 8 div. deflection.
- X POSITION potentiometer R6 at mid-range.
- X MAGN switch S7 to position "X1".
- MTB LEVEL potentiometer R7 at mid-range.
- DTB LEVEL potentiometer R5 at mid-range.
- MTB SLOPE switch S8 in position "+".
- DTB SLOPE switch S6 in position "+".
- MTB TRIGGER source selector switch S22 to position "A".
- DTB TRIGGER source selector switch S21 to position "A".
- MTB TIME/DIV switch S15 to 0,2 ms/div. and potentiometer R12 to CAL.
- DTB TIME/DIV switch S13 to OFF for measuring the diagrams 1-2-3-4-5-6-7-8-9-10-13-14-18a-18b-18d-19a en 19b.
- DTB TIME/DIV switch S13 to 50  $\mu$ s/div. for measuring the diagrams 11-12-15-16-17-18c-18e and 19c.

#### 3.3.3. Remark

In case of a defect it is always possible to apply to the world wide PHILIPS Service Organization. When the instrument is to be sent to a PHILIPS Service Workshop for repair, the following points should be observed:

- Attach a label with your name and address to the instrument.
- Give a complete description of the faults found, or the service required.
- Use the original packing, or, if this is no longer available, carefully pack the instrument in a wooden crate or box.
- Send the instrument to the address obtained after consultation with the local PHILIPS Organization.



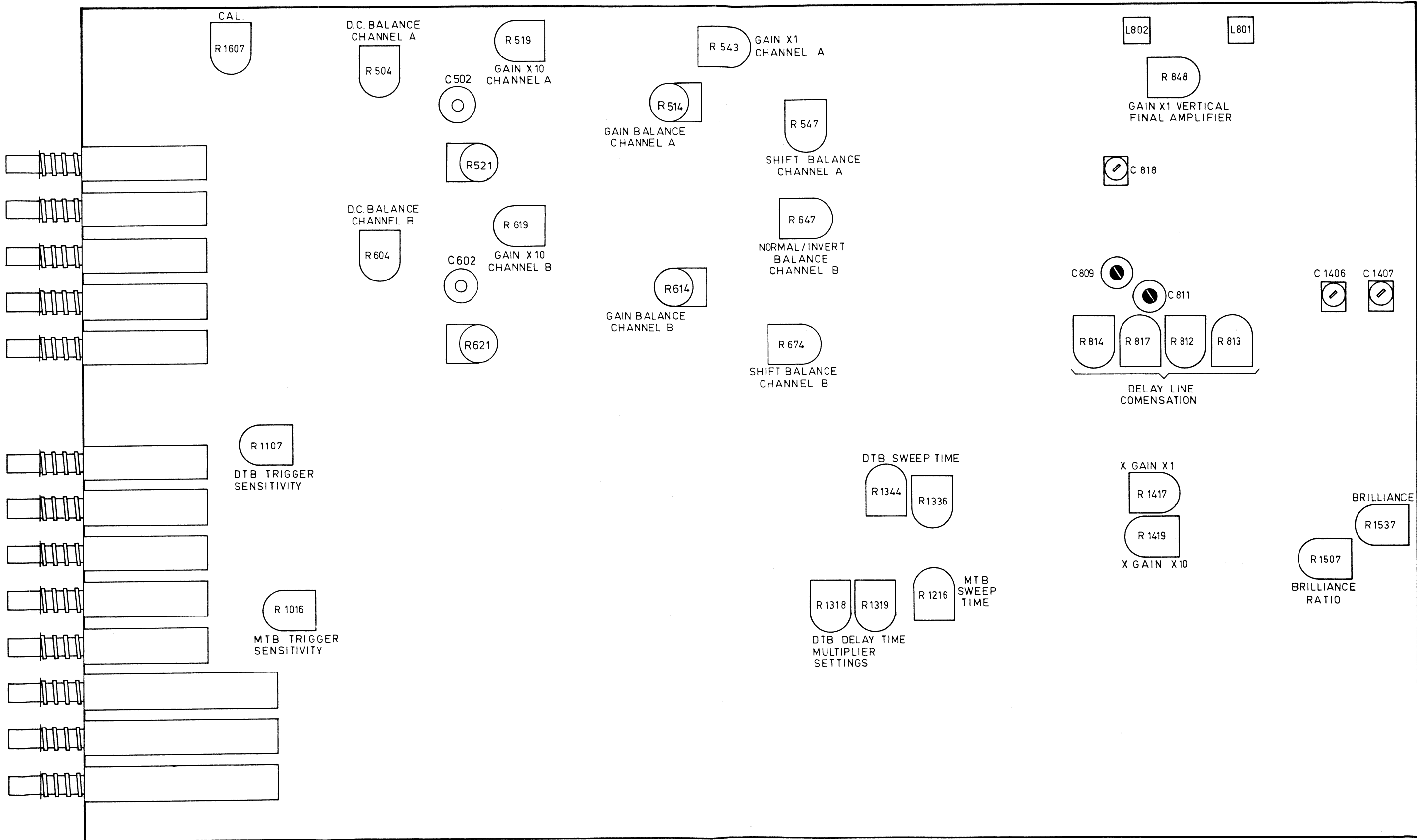


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Fig. 3.19. Adjusting elements amplifier board



### 3.4. DISMANTLING THE INSTRUMENT

#### 3.4.1. General information

This section provides the dismantling procedures required for the removal of components during repair and routine maintenance operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed.

During dismantling procedures, a careful note of all leads disconnected must be made so that they may be reconnected to their correct terminals during assembly.

Always ensure that the mains supply is disconnected before removing any instrument cover plates.

Damage may result if the instrument is switched on when a circuit board has been removed, or if a circuit board is removed within one minute of switching off the instrument.

#### 3.4.2. Removing the instrument covers

The instrument is protected by three covers: a front panel protection cover, a wrap-around cover with carrying handle, and a rear panel.

To facilitate removal of the wrap-around cover and the rear panel, first ensure that the front cover is in position.

Then proceed as follows:

- hinge the carrying handle clear of the front cover; to this end, push both pivot centre buttons (Fig. 3.20).
- stand the instrument on its protective front cover on a flat surface
- slacken the two coin-slot screws located on the rear panel
- lift the rear panel and unplug the connector on the power supply board
- lift off the wrap-around cover
- for access to the front-panel, stand the instrument horizontally and snap off the front cover.

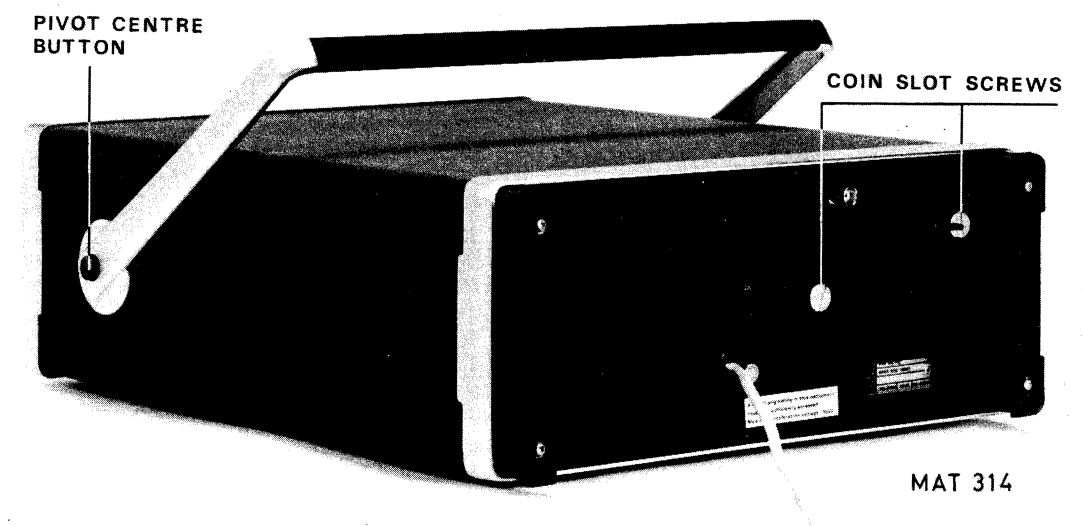


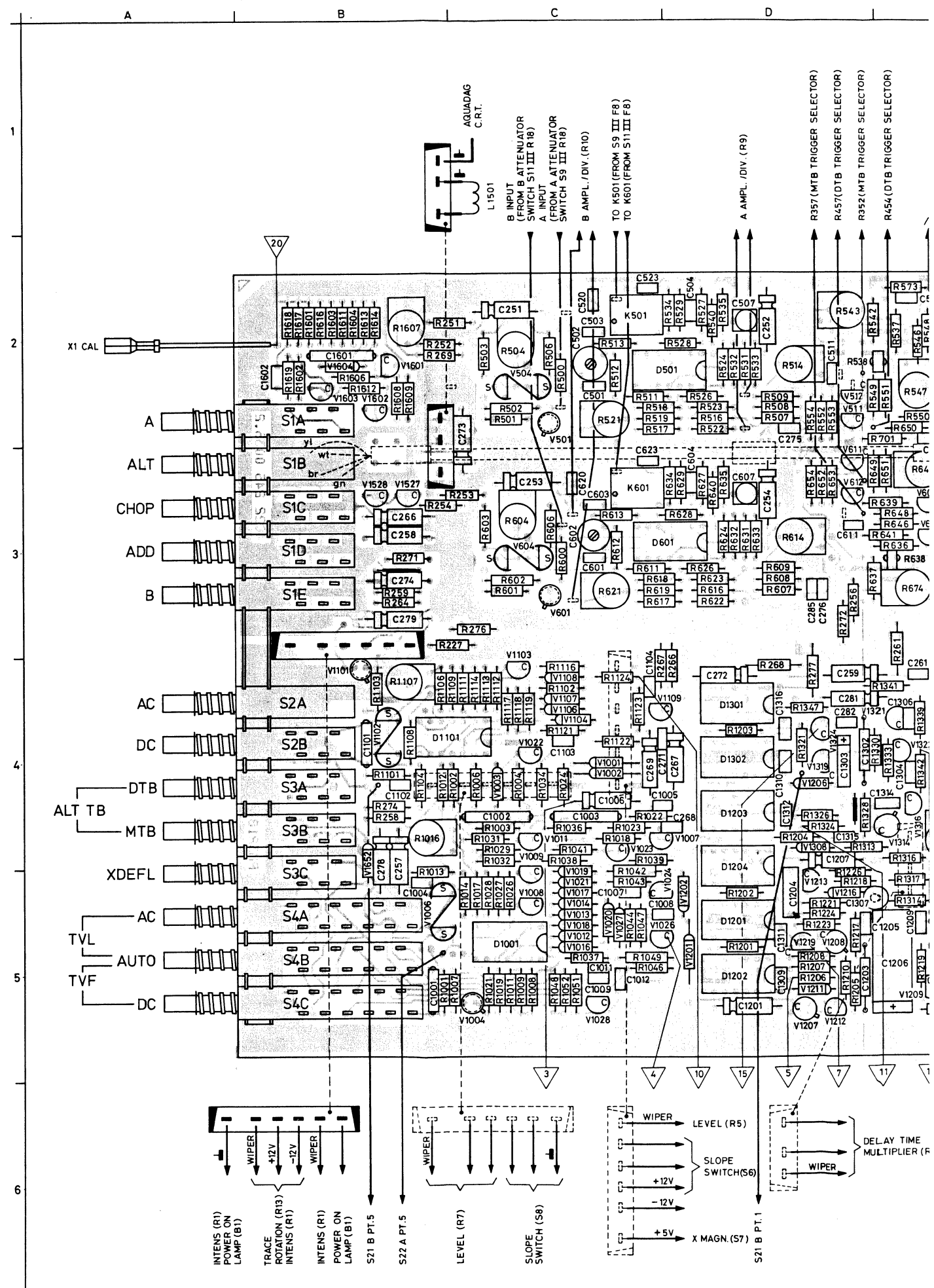
Fig. 3.20. Removing the instrument covers.

## COMPONENT LOCATION LIST

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| Item | Grid loc.               | Item | Grid loc. | Item  | Grid loc. | Item  | Grid loc. | Item  | Grid loc.    | Item | Grid loc. | Item | Grid loc. | Item | Grid loc. | Item | Grid loc. | Item  | Grid loc. |
|------|-------------------------|------|-----------|-------|-----------|-------|-----------|-------|--------------|------|-----------|------|-----------|------|-----------|------|-----------|-------|-----------|
| C101 | rear panel              | C285 | D-3       | C517  | E-2       | C1007 | C-5       | C1509 | G-4          | R267 | C-4       | R413 | on switch | R542 | D-2       | R640 | D-3       | R821  | F-3       |
| C200 | power supply            | C286 | G-3       | C518  | E-2       | C1008 | C-5/D-5   | C1511 | G-5          | R268 | D-4       | R414 | S11       | R543 | D-2       | R641 | D-3/E-3   | R822  | F-3/G-3   |
| C201 | power supply            | C301 | att. unit | C519  | E-2       | C1009 | C-5       | C1512 | on tube      | R269 | B-2/C-2   | R416 | att. unit | R546 | E-2       | R646 | E-3       | R823  | G-3       |
| C202 | power supply            | C305 | att. unit | C520  | C-2       | C1011 | C-5       | C1601 | B-2          | R271 | B-3       | R417 | att. unit | R547 | E-2       | R647 | E-3       | R824  | G-3       |
| C203 | power supply            | C307 | att. unit | C521  | E-2       | C1012 | C-5       | C1602 | B-2          | R272 | D-3       | R418 | att. unit | R548 | E-2       | R648 | E-3       | R825  | G-3       |
| C204 | power supply            | C308 | att. unit | C522  | F-2       | C1101 | B-4       | C1651 | F-4          | R273 | att. unit | R419 | att. unit | R549 | D-2       | R649 | D-3       | R826  | G-3       |
| C206 | power supply            | C309 | att. unit | C523  | C-2       | C1102 | B-4       | C1652 | F-4          | R274 | B-4       | R451 | att. unit | R550 | E-2       | R650 | E-2       | R827  | G-3       |
| C207 | power supply            | C310 | att. unit | C601  | C-3       | C1103 | C-4       | C1653 | F-5          | R276 | C-3       | R452 | att. unit | R551 | E-2       | R651 | E-3       | R828  | G-3       |
| C208 | power supply            | C311 | att. unit | C602  | C-3       | C1104 | C-4       | C1654 | F-5          | R277 | D-4       | R453 | att. unit | R552 | D-2       | R652 | D-3       | R829  | F-3       |
| C209 | power supply            | C312 | att. unit | C603  | C-3       | C1201 | D-5       | C1655 | F-4          | R278 | F-4       | R454 | att. unit | R553 | D-2       | R653 | D-3       | R831  | F-2       |
| C211 | power supply            | C313 | att. unit | C604  | D-3       | C1202 | E-5       | C1656 | F-5          | R279 | G-3       | R456 | att. unit | R554 | D-2       | R654 | D-3       | R832  | F-2       |
| C212 | high<br>tension<br>unit | C314 | att. unit | C607  | D-3       | C1203 | D-5       | C1657 | F-5          | R281 | G-3       | R457 | att. unit | R558 | E-2       | R658 | E-3       | R833  | G-3       |
| C213 |                         | C315 | att. unit | C609  | E-2       | C1204 | D-5       | C1658 | F-5          | R302 | att. unit | R458 | att. unit | R559 | E-2       | R659 | E-3       | R837  | F-3       |
| C214 |                         | C316 | att. unit | C611  | D-3       | C1205 | D-5       | C1659 | F-5          | R303 | on switch | R459 | att. unit | R568 | E-2       | R661 | E-3       | R838  | G-2       |
| C216 |                         | C317 | att. unit | C613  | E-3       | C1206 | E-5       | C1660 | E-3          | R304 | S9        | R461 | att. unit | R569 | E-2       | R662 | E-3       | R839  | F-2       |
| C217 |                         | C318 | att. unit | C616  | E-3       | C1207 | D-4       | R1    |              | R306 |           | R462 | att. unit | R571 | F-2       | R663 | E-3       | R843  | F-2       |
| C218 | power supply            | C319 | att. unit | C617  | E-3       | C1208 | E-5       | R2    |              | R307 | att. unit | R463 | att. unit | R572 | F-2       | R664 | E-3       | R847  | F-2       |
| C219 | power supply            | C320 | att. unit | C618  | E-3       | C1209 | E-5       | R3    |              | R308 | att. unit | R464 | att. unit | R573 | E-2       | R668 | E-3       | R848  | F-2       |
| C221 | power supply            | C321 | att. unit | C619  | F-3       | C1210 | E-4       | R4    |              | R309 | att. unit | R466 | att. unit | R577 | F-2       | R669 | E-3       | R849  | F-2       |
| C222 | power supply            | C322 | att. unit | C620  | C-3       | C1301 | E-5       | R5    |              | R311 | att. unit | R467 | att. unit | R600 | C-3       | R671 | E-3/F-3   | R851  | G-2       |
| C223 | power supply            | C324 | att. unit | C621  | E-3       | C1302 | D-4       | R6    |              | R312 | att. unit | R468 | att. unit | R601 | C-3       | R672 | E-3/F-3   | R852  | F-2       |
| C224 | power supply            | C351 | att. unit | C622  | F-3       | C1303 | D-4       | R7    |              | R313 | on switch | R469 | att. unit | R602 | C-3       | R673 | E-3       | R853  | F-2       |
| C226 | power supply            | C352 | att. unit | C623  | C-3       | C1304 | E-4       | R8    | front panel  | R314 | S9        | R500 | C-2       | R603 | C-3       | R674 | E-3       | R854  | F-2       |
| C227 | power supply            | C353 | att. unit | C701  | E-3       | C1305 | E-5       | R9    |              | R316 | att. unit | R501 | C-2       | R604 | C-3       | R676 | E-3       | R856  | F-2       |
| C228 | power supply            | C356 | att. unit | C702  | E-2       | C1306 | E-4       | R10   |              | R317 | att. unit | R502 | C-2       | R606 | C-3       | R677 | F-3       | R857  | F-2       |
| C229 | power supply            | C401 | att. unit | C703  | E-3       | C1307 | D-5/E-5   | R11   |              | R318 | att. unit | R503 | C-2       | R607 | C-3       | R701 | E-2/E-2   | R858  | F-2       |
| C231 | power supply            | C405 | att. unit | C704  | E-3       | C1308 | E-5       | R12   |              | R319 | att. unit | R504 | C-2       | R608 | C-3       | R702 | E-3       | R859  | F-2/G-2   |
| C251 | C-2                     | C407 | att. unit | C705  | E-2       | C1309 | D-5       | R13   |              | R351 | att. unit | R506 | C-2       | R609 | C-3       | R703 | E-2       | R861  | F-2       |
| C252 | D-2                     | C408 | att. unit | C706  | E-2       | C1310 | D-4       | R14   |              | R352 | att. unit | R507 | D-2       | R611 | C-3       | R704 | E-2       | R862  | F-2/G-2   |
| C253 | C-3                     | C409 | att. unit | C707  | F-2       | C1311 | D-5       | R15   |              | R353 | att. unit | R508 | D-2       | R612 | C-3       | R706 | E-3       | R863  | F-2       |
| C254 | D-3                     | C410 | att. unit | C801  | F-3       | C1321 | D-4       | R200  | power supply | R354 | att. unit | R509 | D-2       | R613 | C-3       | R707 | E-2/E-3   | R864  | G-2       |
| C255 | att. unit               | C411 | att. unit | C802  | F-3       |       |           | R201  | power supply | R355 | att. unit | R511 | C-2       | R614 | D-3       | R708 | E-2/E-3   | R866  | F-2/F-3   |
| C256 | att. unit               | C412 | att. unit | C803  | F-3       | C1314 | E-4       | R202  | power supply | R356 | att. unit | R512 | C-2       | R616 | D-3       | R709 | F-2       | R1001 | B-5       |
| C257 | B-4/B-5                 | C413 | att. unit | C804  | F-3       | C1315 | D-4       | R203  | power supply | R357 | att. unit | R513 | C-2       | R617 | C-3/D-3   | R711 | F-3       | R1002 | C-4       |
| C258 | B-3                     | C414 | att. unit | C805  | G-2       | C1316 | D-4       | R204  | power supply | R358 | att. unit | R514 | D-2       | R618 | C-3/D-3   | R712 | F-2       | R1003 | C-4       |
| C259 | D-4                     | C415 | att. unit | C806  | F-3       | C1402 | F-5       | R206  | power supply | R359 | att. unit | R516 | D-2       | R619 | C-3/D-3   | R713 | E-3       | R1004 | C-4       |
| C261 | E-4                     | C416 | att. unit | C807  | F-3       |       |           | R207  | power supply | R360 | att. unit | R517 | C-2/D-2   | R621 | C-3       | R714 | E-2       | R1006 | C-4       |
| C262 | F-5                     | C417 | att. unit | C808  | F-3       | C1404 | G-3       | R208  | power supply | R361 | att. unit | R518 | C-2/D-2   | R622 | D-3       | R716 | F-3       | R1007 | C-5       |
| C263 | E-4                     | C418 | att. unit | C809  | F-3       | C1405 | G-3       | R209  | power supply | R362 | att. unit | R519 | C-2/D-2   | R623 | D-3       | R717 | F-3       | R1008 | C-5       |
| C266 | B-3                     | C419 | att. unit | C810  | F-2       | C1406 | G-3       | R210  | power supply | R363 | att. unit | R521 | D-2       | R624 | D-3       | R801 | F-2       | R1009 | C-5       |
| C267 | D-4                     | C420 | att. unit | C811  | F-3       | C1407 | G-3       | R211  | high t.u.    | R364 | att. unit | R522 | D-2       | R626 | D-3       | R802 | F-3       | R1011 | C-5       |
| C268 | D-4                     | C421 | att. unit | C812  | G-3       | C1408 | G-3       | R212  | power supply | R365 | att. unit | R523 | D-2       | R627 | D-3       | R803 | F-3       | R1012 | B-4       |
| C269 | C-4                     | C422 | att. unit | C813  | G-3       | C1409 | G-2       | R227  | B-3/C-3      | R366 | att. unit | R524 | D-2       | R628 | D-3       | R804 | F-2       | R1013 | B-5       |
| C271 | C-4                     | C424 | att. unit | C814  | G-2       | C1411 | G-3       | R251  | B-2/C-2      | R367 | att. unit | R526 | D-2       | R629 | D-3       | R806 | F-3       | R1014 | C-5       |
| C272 | D-4                     | C451 | att. unit | C815  | G-3       | C1412 | G-2       | R252  | B-2/C-2      | R368 | att. unit | R527 | D-2       | R631 | D-3       | R807 | F-3       | R1016 | B-4       |
| C273 | C-2/C-3                 | C452 | att. unit | C816  | F-2       | C1413 | G-2/G-3   | R253  | B-3/C-3      | R369 | att. unit | R528 | D-2       | R632 | D-3       | R809 | F-2/F-3   | R1017 | C-5       |
| C274 | B-3                     | C453 | att. unit | C817  | F-2       | C1414 | G-2/G-3   | R254  | C-3          | R374 | att. unit | R529 | D-2       | R633 | D-3       | R811 | F-3       | R1018 | C-4       |
| C276 | D-3                     | C501 | C-2       | C818  | F-2       | C1416 | G-2       | R256  | D-3          | R402 | att. unit | R531 | D-2       | R634 | D-3       | R812 | F-3       | R1019 | C-5       |
| C277 | att. unit               | C502 | C-2       | C821  | F-2       | C1417 | G-2       | R257  | att. unit    | R403 | on switch | R532 | D-2       | R635 | D-3       | R813 | G-3       | R1021 | C-5       |
| C278 | B-4/B-5                 | C503 | C-2       | C1001 | B-5       | C1501 | G-5       | R258  | B-4          | R404 | S11       | R533 | D-2       | R636 | E-3       | R814 | F-3       | R1022 | C-4       |
| C279 | B-3                     | C504 | D-2       | C1002 | C-4       | C1502 | G-5       | R259  | B-3          | R406 |           | R534 | D-2       | R637 | D-3/E-3   | R816 | F-3       | R1023 | C-4       |
| C280 | att. unit               | C507 | D-2       | C1003 | C-4       | C1503 | G-5       | R261  | E-3/E-4      | R407 | att. unit | R535 | D-2       | R638 | E-3       | R817 | F-3       | R1024 | C-4       |
| C281 | D-4                     | C509 | E-2       | C1004 | B-5       | C1504 | G-5       | R262  | F-5          | R408 | att. unit | R536 | E-2       | R639 | D-3/E-3   | R818 | F-2       |       |           |
| C282 | D-4                     | C511 | D-2       | C1005 | C-4/D-4   | C1506 | G-4       | R263  | E-3/E-4      | R409 | att. unit | R537 | E-2       |      |           | R819 | F-3       |       |           |
| C283 | F-4                     | C513 | E-2       | C1006 | C-4       | C1507 | G-5       | R264  | B-3          | R411 | att. unit | R538 | D-2/E-2   |      |           |      |           |       |           |
| C284 | G-2                     |      |           |       |           | C1508 | G-5       | R266  | D-4          | R412 | att. unit | R539 | E-2       |      |           |      |           |       |           |
|      |                         |      |           |       |           |       |           |       |              |      |           | R540 | D-2       |      |           |      |           |       |           |
|      |                         |      |           |       |           |       |           |       |              |      |           | R541 | E-2       |      |           |      |           |       |           |







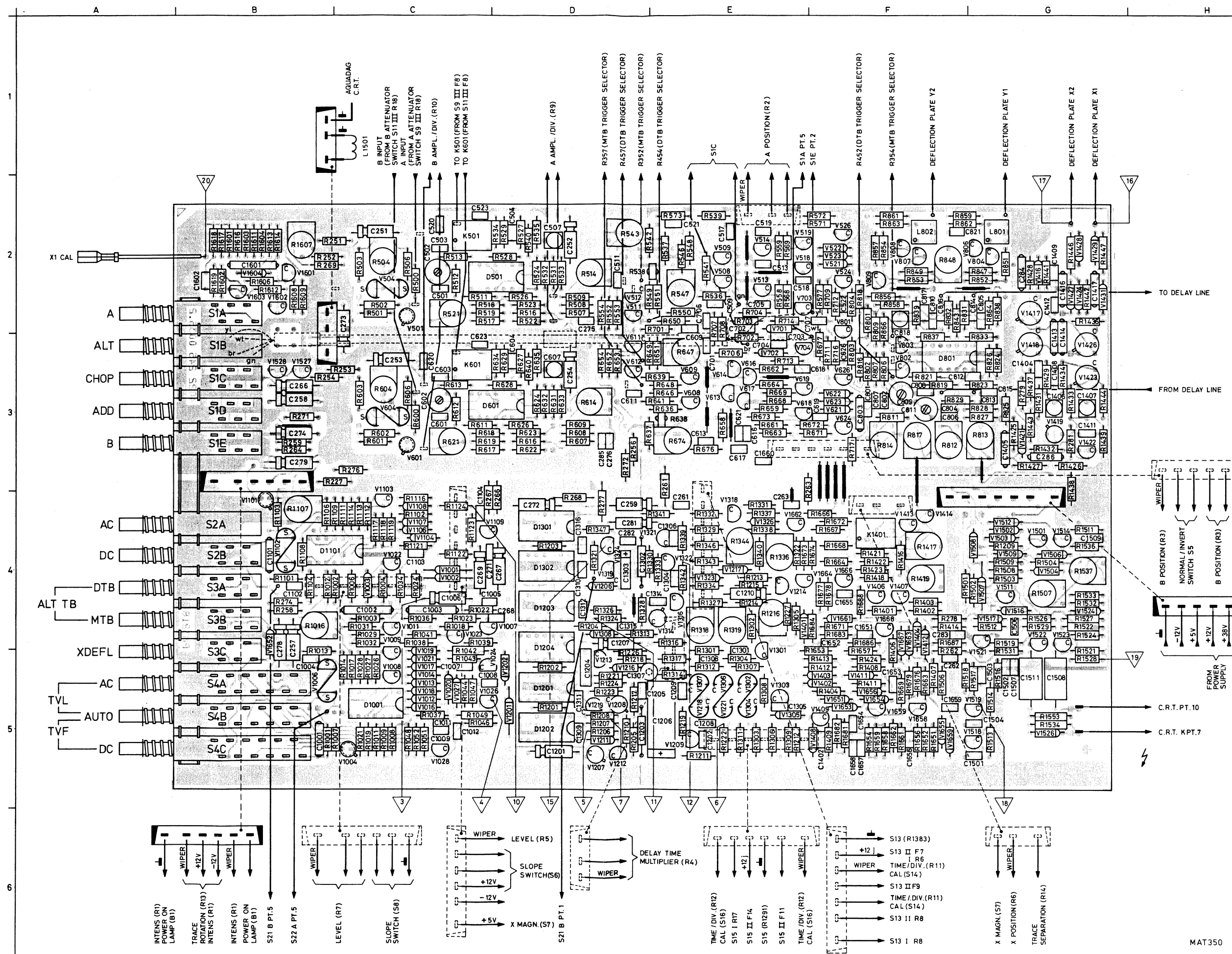
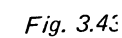
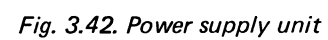


Fig. 3.40. Vertical amplifier unit with rear side tracks





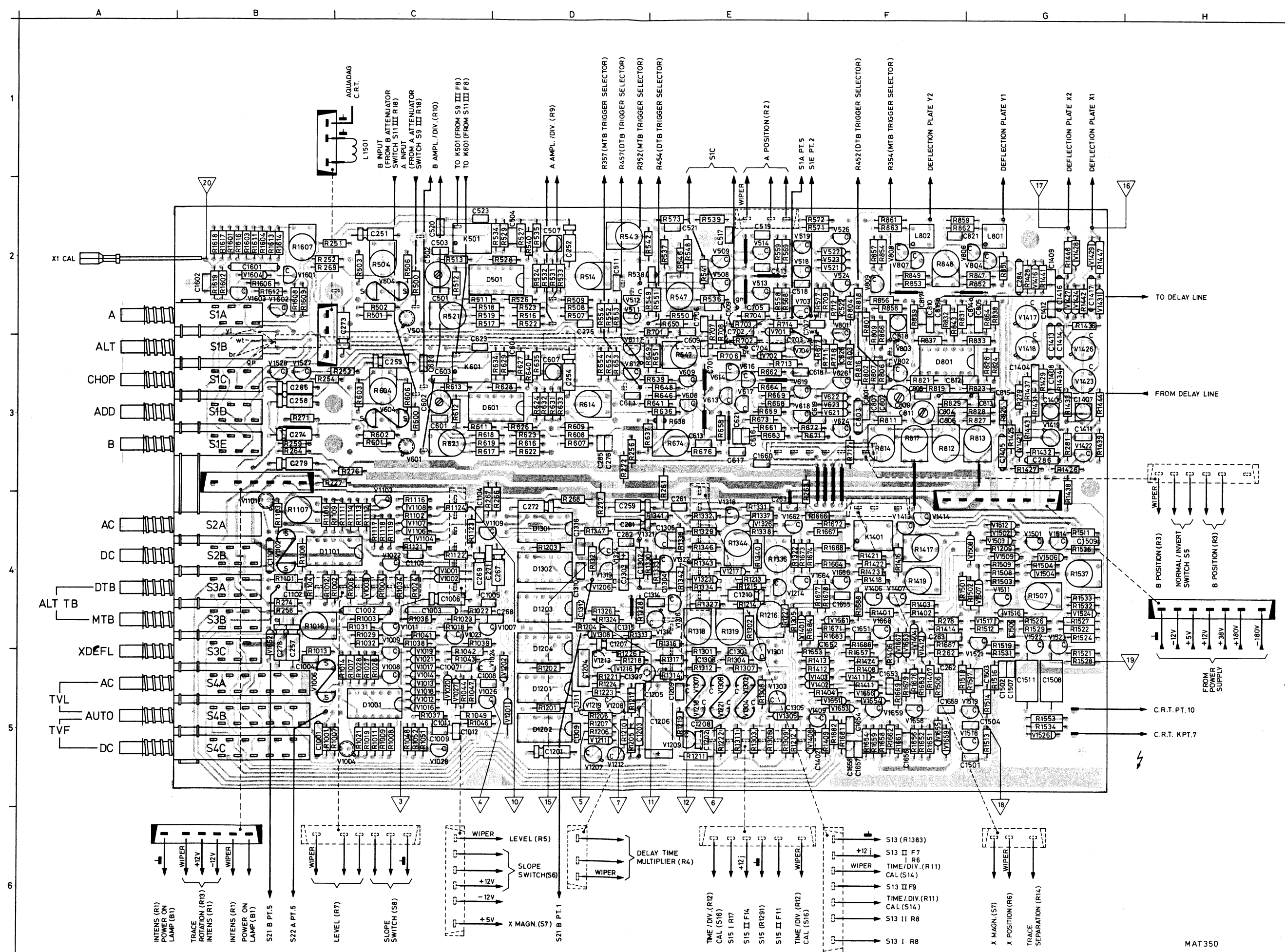
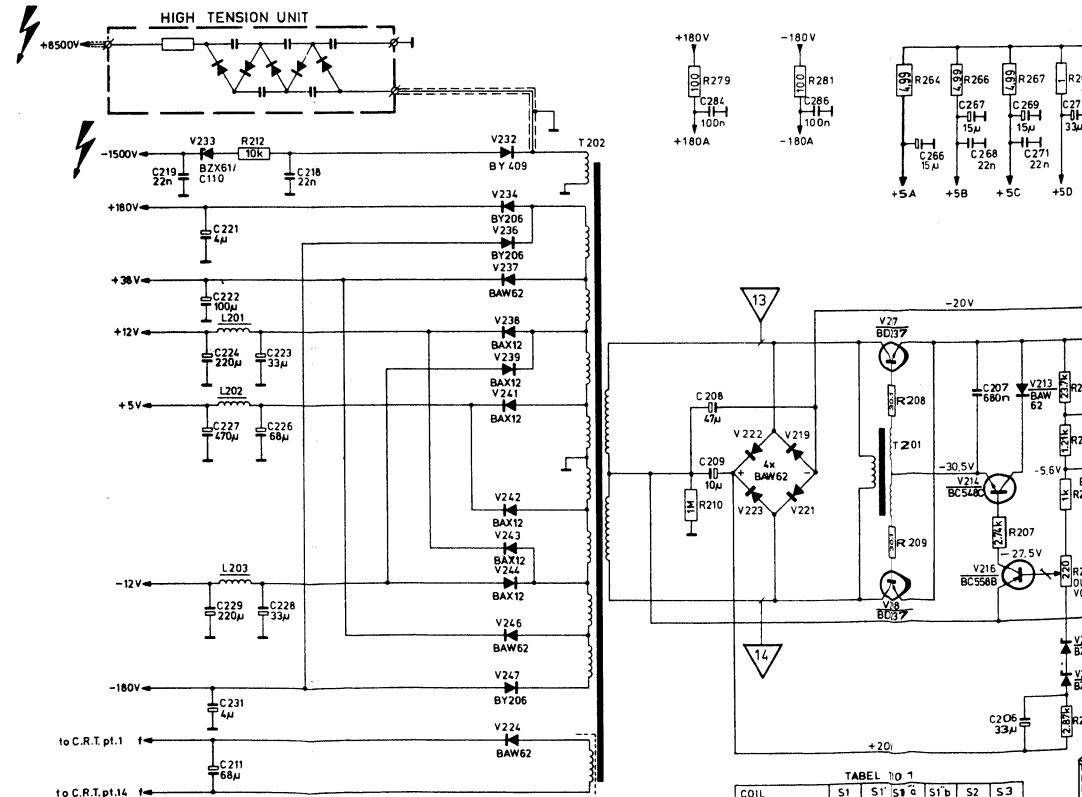
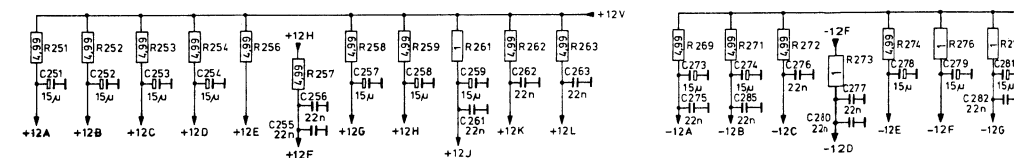
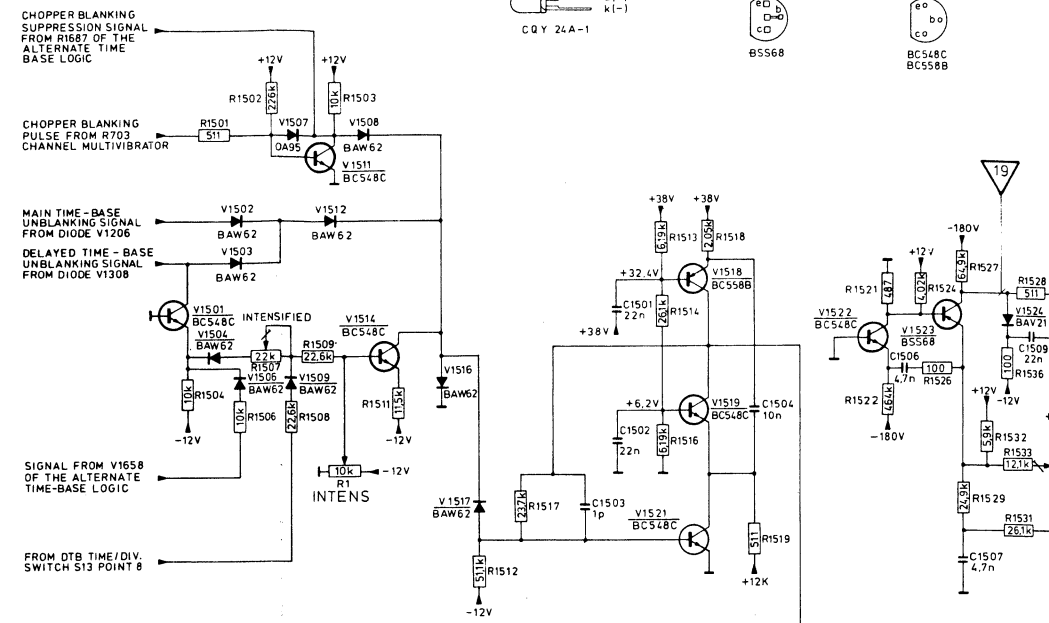
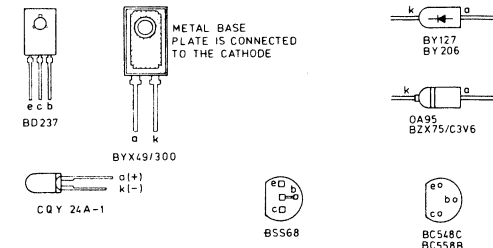
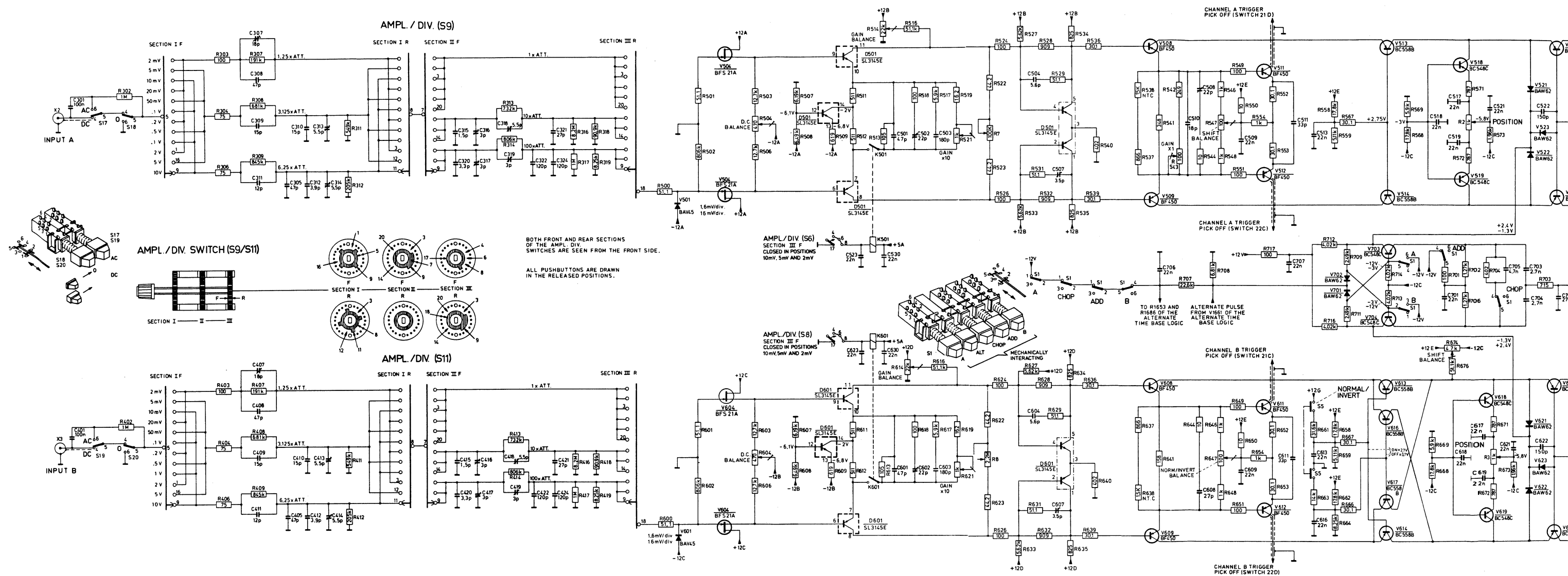


Fig. 3.43. Vertical amplifier unit with upper side tracks



| TABLE 10.1     |       |       |       |       |        |         |          |           |            |
|----------------|-------|-------|-------|-------|--------|---------|----------|-----------|------------|
| COIL           | S1    | S1'   | S1''  | S1''' | S1'''' | S1''''' | S1'''''' | S1''''''' | S1'''''''' |
| CONNECTIONS    | 1-2   | 3-4   | 5-6   | 7-8   | 9-10   | 11-12   | 13-14    | 15-16     | 17-18      |
| URNS           | 530   | 82    | 82    | 530   | 115    | 115     | 530      | 82        | 82         |
| R.M.S. VOLTAGE | 110V  | 17V   | 17V   | 110V  | 24V    | 24V     | 110V     | 17V       | 17V        |
| R20°C ± 10°C   | 285Ω  | 4.5Ω  | 4.5Ω  | 285Ω  | 10     | 10      | 285Ω     | 4.5Ω      | 4.5Ω       |
| 20°C           | 0.224 | 0.224 | 0.224 | 0.224 | 0.63   | 0.63    | 0.224    | 0.224     | 0.224      |





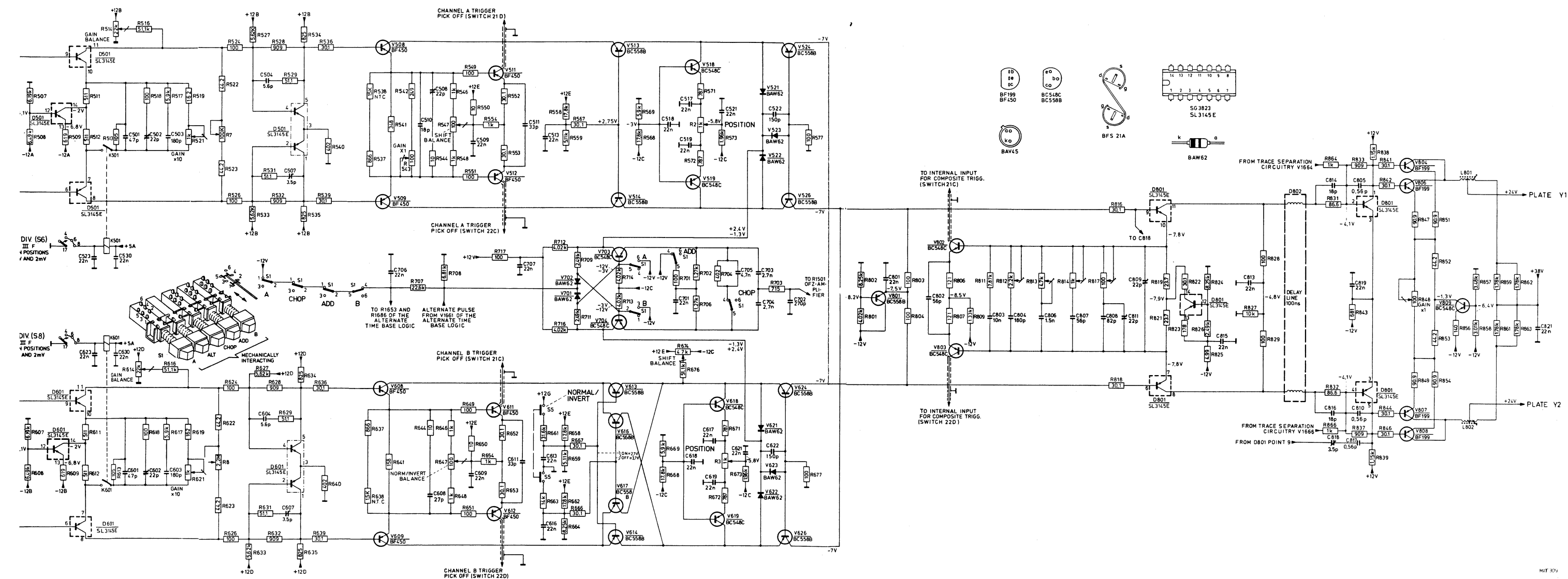
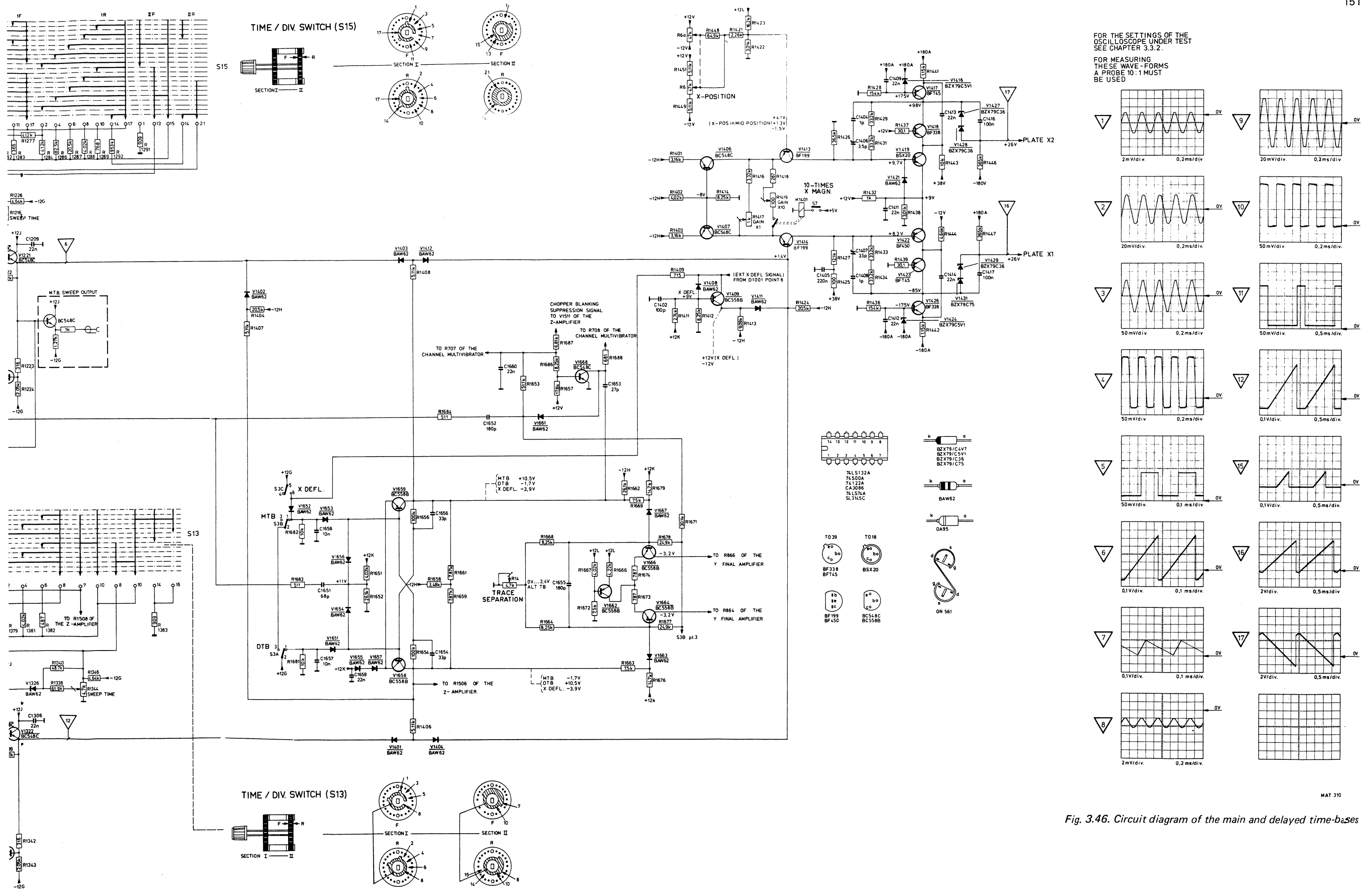


Fig. 3.45. Circuit diagram of the vertical amplifiers



*Fig. 3.46. Circuit diagram of the main and delayed time-bases*





